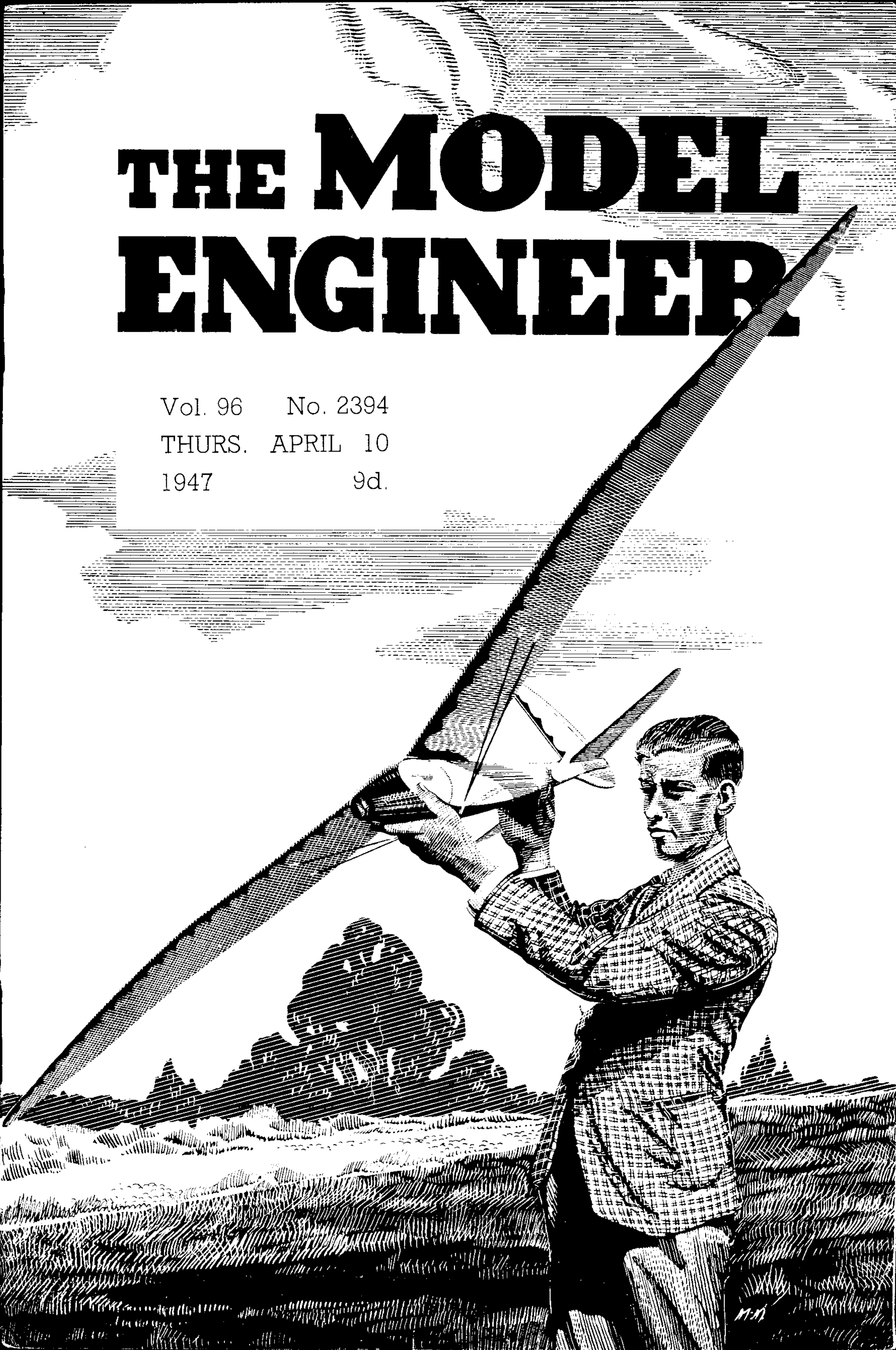
THE MODEL ENGINEER

Vol. 96 No. 2394
THURS. APRIL 10
1947 9d.



THE MODEL ENGINEER

Percival Marshall & Co. Ltd., 23, Great Queen Street, London, W.C.2

SMOKE RINGS

Our Cover Picture

OUR artist has chosen for his subject this week a beautifully proportioned sailplane which has been designed and built by Mr. M. W. White, of the Blackheath Model Flying Club. To see such a fine model soaring high above is a sight which thrills all modellers, particularly the designer, who is thus able to see the result of his skill and workmanship in its element. The photograph on which the drawing has been based was taken by Mr. E. F. H. Cosh, of our sister journal, *Model Aircraft*, which caters for all aspects of this popular branch of model engineering.

A Club Team Competition Trophy

HERE is something for club members and executives to think about. In the Competition Section of the forthcoming "M.E." Exhibition we are offering a special Club Cup for the best team exhibit by the members of any established model engineering society. The methods of entering for and of awarding the cup are very simple. Any club desiring to compete must be represented by no fewer than three individual entries of work by members, submitted in the usual way. When the club committee knows which of its members are sending competition entries, it selects from among these the three entries which it considers to be the best pieces of work and writes to the Exhibition Manager a letter making official nomination of these exhibits as the Club's team. Models and other work so selected will, of course, be eligible for the ordinary competition cups or other prizes on their individual merits and will be marked by the judges in the normal way. The marks allotted to the various "team" models will then be added up and the club whose representatives score the highest total number of marks will receive the Club Cup, to be permanently retained and used as it may deem best. Each club will be free to adopt its own method of selecting the models it wishes officially to nominate, but it occurs to me that it might be a good thing to hold a special nomination meeting prior to sending in the official list, so that members could vote for the models which they would like to represent the Club. This would relieve the Committee from any suggestion of partiality, and would allow all the members to feel that they had a direct interest in the success of their Club in the competition. It will be noted that this contest does not depend on a large number of exhibits, so that a club with a modest membership but with some clever craftsmen in its ranks stand as good a chance of distinction as any one of the larger clubs. The honour of being the Champion Club of the year is well worth winning, and will, I hope, be the subject of especially keen competition. Any club may, of course, send more than three models to the show, but only the three officially nominated exhibits will count in the team judging. In accordance with our normal competition

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conditions only new models not previously entered will be eligible. Entry forms will be ready shortly.

A Club for Edgware

AN addition has been made to the number of clubs in the London area by the formation of the Edgware and District Society, which has just made a successful start. Meetings are to be held on alternate Wednesdays at the Edgware Parish Church Hall, Scouts Hut. The Club has a workshop available, and has obtained permission to lay a multi-gauge locomotive track, and a cement track for model racing cars in the Rectory Grounds. The Hon. Secretary, Mr. John W. Reed, 60, Ennerdale Drive, Kingsbury, N.W.9, invites local enthusiasts to make contact.

The Shipwrights' Exhibition

I AM indebted to Mr. Walter Pollock, the Chairman of the Exhibition Committee, for an interesting "retrospect" recording some striking facts in regard to the success of this show. It is pleasing to learn that in spite of the appalling weather conditions, as many as 51,750 visitors inspected the exhibits, of whom about one-half comprised students, apprentices, naval cadets, and sea scouts who were guests of the of the Company, of these over 4,000 attended the sessions at which various papers on marine matters were read, and nearly 7,000 saw the various films loaned by the Admiralty, the Central Office of Information, and individual firms. From this it will be gathered that the educational purpose of the Exhibition was very fully served. There were 178 exhibitors, and a waiting list of 58 firms for whom accommodation could not be found. The model of the Doxford diesel engine illustrated in our issue of March 20th, was awarded the Billmeir Plaque for the best model marine engine. A permanent and most useful souvenir of the occasion is the handsome volume issued by the Company, containing the text of the various technical papers read in the course of the show. Shiplovers will be glad to know that the Shipwrights' Company contemplate another exhibition on a much larger scale in about five years' time. We owe the Company an apology for a slip of the pen which occurred in the article by Mr. Edward Bowness in our March 20th issue. It was stated that the Exhibition took place at the Agricultural Hall, instead of at the Royal Horticultural Hall.

Wanted—A Million Matches

THIS is an unusual request for a reader to make and may raise a smile, but there is a serious purpose behind it. The appeal comes from Mr. Bravery, who, it may be remembered exhibited a model house and a model church at our 1946 exhibition, both made entirely from matches. These were so neat and so clever in the use of this humble material that Mr. Bravery was awarded a bronze medal. He is now embarking on the construction of another house and a lighthouse, for which purpose he requires to collect a million or so used matches. A gardener by occupation, he is unfortunately partially crippled and is confined to bed for considerable periods, during which he carries on with his model making. He would be grateful for any consignments of used matches which fellow readers may be able to send him. His address is 1, The Bungalow, Woodcote Grove House, Coulsdon, Surrey. It is a far cry from the wonderful engineering models which our general readers build in iron, steel, and gunmetal, to the simple match-stick as a constructive material, but there is behind it the same love of craftsmanship and desire to produce a fine model which animates all true model engineers, and I am sure that Mr. Bravery's patient endeavours in spite of his physical disabilities will gain for him the sympathetic appreciation of his more fortunate contemporaries in the model making world. So if there are any used matches lying around at home, you know where they will find a welcome.

Indian Model Makers

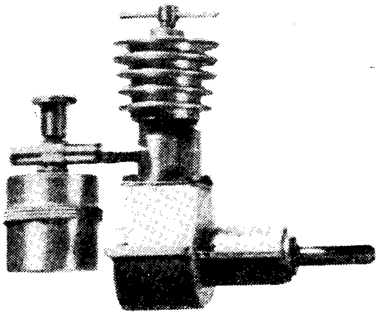
PAYING one of my occasional visits to the cinema a few days ago I was pleasantly surprised to see a short-feature depicting model making activities by native craftsmen in Southern India. The principal model under construction was a very elaborate temple, made in a soft and easily worked material known as "pith-wood," which I imagine to be either what we know as balsa wood, or a near relative thereto. This model making is not an individual hobby but a long established local industry handed down from generation to generation. In the picture I saw a father, son, and grandson, all at work on making the component parts of the spectacular temple model. Metal work is also carried on, and some of the methods employed in making iron castings of artistic figures were surprisingly like iron foundry work in our own country. They even used wax patterns for some of the elaborate figure castings, the wax pattern being melted out of the mould before pouring the metal in, a useful method for a "one-off" artistic casting. Sand moulding with solid wooden or metal patterns, in two moulding boxes, was quite a normal procedure for some of the work in progress, and I was much interested in seeing a native metal turner at work. He had a very simple type of centre lathe resting on the ground, and was engaged in turning the tapered column of a brass lampstand. He used a hand tool with a long handle held partly by his fingers and partly by his toes as he sat on the ground beside the lathe. The lathe was belt driven; the source of power was not visible in the picture but I imagine it was a large hand-wheel patiently turned by another member of the family. The tool appeared to cut evenly and well. I think we can assume that labour costs in this primitive industry are very low, but it is obvious that ingenuity, artistic feeling, and handicraft skill are inherited traditions in this clever native community. Will these attributes ever be applied to model engine making? I wonder.

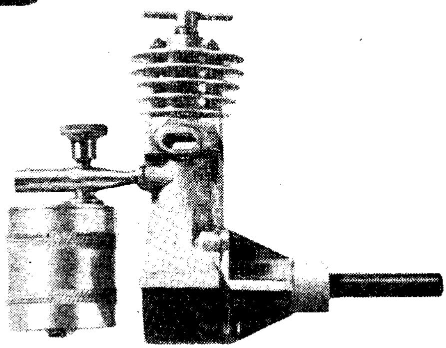
Percival Marshall

COMPRESSION-IGNITION ENGINES

By " Battiwallah "

THE purpose of this article is to describe the principles of compression-ignition engines of a few cubic centimetres capacity which have been constructed by an amateur with only amateur's workshop equipment.





Before getting down to the details of construction, let us first discuss the general principles.

Although there is nothing new in compression-ignition as utilised in diesel engines, the principle as applied to small units is of fairly recent development, the initial work having been done mainly on the Continent.

The attraction of the small compression-ignition engine lies in the elimination of electrical firing devices. This is an advantage to those whose aim is to obtain a maximum power for a minimum of weight—model aircraft constructors, for example. From my own limited experience with small petrol engines, it seems that the most capricious and least reliable components of the *tout ensemble* are the electrical ones, especially those of the light-weight variety.

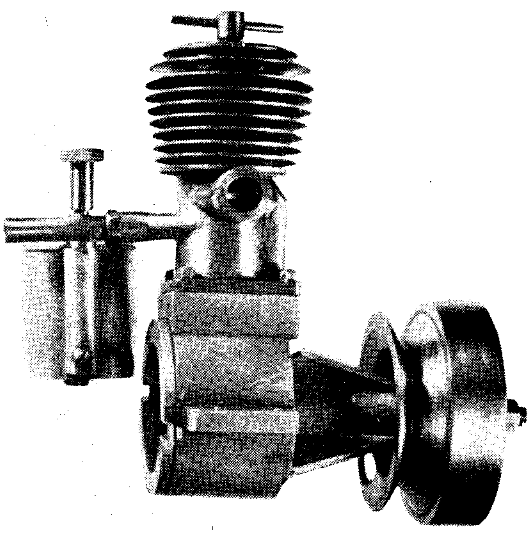
Whilst the weight of a compression-ignition engine is less than that of a petrol engine of equal c.c. capacity complete with its coil and battery, the weight-gain in favour of the compression-ignition engine is not equal to the weight of the said electrical gear. The compression-ignition engine needs a somewhat more robust build, as it has to withstand higher internal pressures.

The Compression-Ignition Principle

The essential difference between our small compression-ignition engines and true diesel engines is this. In the latter, air is drawn into the cylinder during the induction stroke, compressed on the return stroke, and liquid fuel is sprayed into the combustion chamber just before dead top centre by a high-pressure fuel pump. The air having been compressed to 400 lb./sq. in. or more, the temperature it attains is sufficient to fire the fuel-air-mixture, and the working stroke follows. In the little compression-ignition engines, the fuel-air mixture is drawn into the crankcase, compressed, and then induced into the cylinder *via* a transfer port in precisely the same way as in a two-stroke petrol engine. The mixture is again compressed in the cylinder on the up-stroke, to an extent which elevates its temperature sufficiently to cause it to fire, whence the working stroke follows.

Thus, there is no fuel injection in the true sense of the diesel principle, hence, the name diesel applied to the small units we are discussing is really a misnomer, although it seems to be fairly commonly used.

I am not aware that any true diesel of a few c.c.'s capacity ever has, or ever can be constructed. The two difficulties to be overcome are, firstly, to obtain a combustion chamber and cylinder strong enough to withstand the pressures, yet of small enough mass not to absorb so much heat, as will prevent the fuel-air mixture from igniting, and secondly, the practical difficulties of constructing a fuel pump



which will deal with the extremely small quantities of fuel to give the right mixture.

Model compression-ignition engines are, as will be gathered, of the two-stroke type. I see no reason why they could not be made to work on the four-stroke principle, though I have not heard of this having yet been done. I am minded to try, given time and opportunity.

Special Fuel

The little compression-ignition engines will not work with petrol or diesel fuel oil. A special fuel is necessary. It consists of a mixture of about equal parts of ethyl ether and benzine, petrol, or paraffin, to which about 20 per cent. by volume of the combined fuels, medium grade motor car engine oil should be added. Expressed as proportions of 100 parts :—

Ethyl Ether	40 per cent.
Petrol, Benzine, or Paraffin ..	40 per cent.
Lubricating Oil	20 per cent.

The compression ratio in these small engines is from 16 : 1 to 20 : 1, at which a temperature sufficiently high to ignite the ether occurs, which in turn fires the other constituents of the fuel. Ethyl ether is highly volatile ; hence, it is advisable to mix only small quantities of fuel at a time, and always to keep the container well corked, for the loss of the ether constituent will render the fuel unsuitable for use. Simply adding ether to replace evaporation is usually unsatisfactory.

For a particular fuel mixture, the compression ratio is critical. The latter must, therefore, be varied to suit a particular fuel. The provision of a variable compression feature is the main constructional difference between compression-ignition and petrol engines. It is usually done by means of a tightly-fitting piston at the cylinder head ; the distance between the working piston top and this compression regulating piston is adjusted by a screw in the cylinder head or cover. In a French make of engine, the compression is varied by an eccentric movement of the crankshaft bearings. Again, in other makes, the compression ratio is fixed, and the fuel mixture has to be adjusted to a nicety to suit. On the whole, the variable compression feature with the adjustable piston seems to be the best.

The carburettors of compression-ignition engines are very similar to those having a fixed air passage and an adjustable coned needle, used on petrol engines. The jet adjustment must be very positive, and so arranged that no air leaks occur through the jet adjusting-needle screw.

Constructional Notes

With compression-ignition engines, there are certain features and processes in construction which, although relevant to designs other than that which will be described, will be dealt with fully as we come to the instructions for making the parts to which these features or processes apply. There may, of course, be alternatives to some of the methods which will give equally satisfactory results, more especially for those who have available the facilities of a precision workshop and the skill to use them.

Extreme accuracy is absolutely essential for success in constructing compression-ignition engines, that is so far as all working parts are concerned. Generally, also, these parts must be made of high-grade mild steels, well case-hardened for durability.

"Accuracy"

At the risk of incurring the wrath of the petrol engine constructors whose watchword is accuracy, may I say that with this class of engine a reasonable degree of tolerance in fits is permissible. Moreover, a petrol engine which was originally precision-finished will continue to give some sort of performance after wear and tear have taken their toll of the piston and cylinder. With compression-ignition engines, however, the maintenance of a highly accurate fit of the piston and cylinder is the very life and soul of the engine. By highly accurate, I do not mean the usual micrometer accuracy of half a mil., but getting down to tolerances of the order of 0.0001 in., or probably less. A fit so close, and finished surfaces so smooth, that holding a small piston in the hand for a minute or so makes it "no go" or too tight in its cylinder, whereas with both parts at the same temperature, the fit is just right.

All this may seem much more formidable than it really is. The required results can be achieved by simple home-made laps ; elaborate grinding machinery is by no means essential. All that is essential is patience—and plenty of it, too !

Unless these fine working limits are adhered to, the constructor will suffer disappointment after many hours of painstaking labour, for the little engine will simply not work at all. Let there be no doubt about this.

And just a final word on suitable sizes for these little engines before we begin to describe the construction of an actual example.

It has already been stated that the compression ratio is of the order of 16 : 1 to 20 : 1 ; at the higher figure, and assuming that the initial pressure in the cylinder at the beginning of the compression stroke is one atmosphere, the final absolute pressure just before ignition will be twenty atmospheres, or about 280 lb./sq. in. gauge pressure, if no leakage occurs, and there is no very appreciable temperature rise. There must be some slight leakage, however well made the engine may be, and there must be a temperature rise. Hence, roughly speaking, we may say that leakage and temperature rise effects upon the pressure will about cancel out, and we have to consider pressures of, roundly, 300 lb./sq. in.

Effort and Stress

Now to turn over a small engine against compression pressures of this order requires quite a considerable effort, one which will impose a considerable stress on the engine mountings and the crankshaft. The larger the cylinder capacity of the engine, the greater will those stresses be.

Engines of the type in question are generally started with less strain on the mountings when used in model aircraft, for a flick-over of the airscrew is a more gentle means of applying the necessary torque than the tug on the string starter used for starting similar engines fitted into model boats and cars.

Again, the size of the engine is a function of

the desired power, hence the starting effort should not be considered in terms of a petrol engine capacity. I cannot define any rules other than these; for model aircraft, 5-6 c.c. will be adequate for planes up to 6-ft. wing span, provided, of course, that the engine develops its proper power; for motor boats and cars in which larger units are required, careful consideration must be given to the engine mountings and the accessibility of the starting gear.

I have made a 16-c.c. unit which works well and develops astonishing power. Turning it for starting with a string, or rather a rope, for I can find no string strong enough, means a fairly "hefty" tug, and I am sure that it would need some very firm fixings if used for a boat. This engine will drive an 18-in. airscrew with ease, and which, I am told, is only likely to be required on a very much out-size model aircraft.

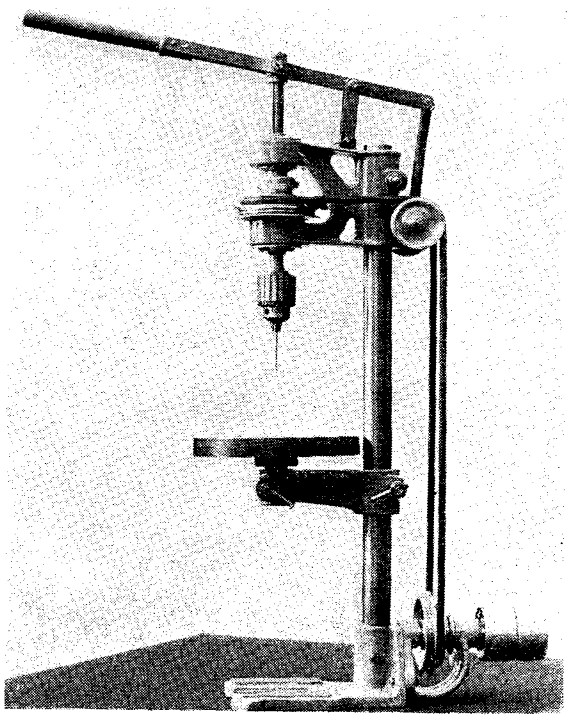
To sum up on the question of engine sizes, no starting problem arises for sizes up to 5-6 c.c., which size will meet the needs of model aircraft constructors, motor boat and car constructors content with modest speeds, and other applications for which engines of this size are suitable. For those who wish to avail themselves of the very high power of large units there is, very definitely, a problem to be solved in the starting arrangements. This last I must leave to the enthusiasts who desire to utilise the compression-ignition engine.

(To be continued)

A MODIFIED "M.E." DRILLING MACHINE

By S. W. C. Coulter

THE machine shown in the photograph was designed on the basis of THE MODEL ENGINEER sensitive drilling machine, but with certain minor alterations and detail improvements. Among the latter may be mentioned the increase in the radial capacity to $3\frac{1}{2}$ in. and the use of ball-bearings to the spindle. As will be seen, the bearing housings of the headstock are enlarged and bored to take ball-races, in which are fitted a steel sleeve; the spindle slides through the sleeve, having the usual long keyway for drive by a feather key from the sleeve. In this way, the spindle is only subjected to sliding wear, and the side pull of the belt is not communicated to it; all rotating and side thrusts being taken, through the sleeve on the ball-races.



The head, table bracket and pulleys were cast at home, in aluminium alloy obtained from scrap motor-car pistons. Machining was carried out on a 4-in. Drummond lathe. The base was mounted on an angle-plate on the cross slide and bored for the column, after which a short length of 1-in. steel shafting was fitted, and the headstock (which had previously been bored to fit the column) mounted on it, without removing from the cross slide. By swinging the saddle around the bed, it was possible to bring the spindle bearing centre in line with the lathe centres, for boring the housings. A similar procedure was adopted for boring the table bracket, with the assurance that the alignment of all essential parts must be correct.

Dust covers are fitted on each side of the ball-races, one of the latter being positively located endwise to prevent movement. It will be seen that no end thrust is transmitted to the ball-races, which take radial load only; the thrust bearing is of the same type as in the original MODEL ENGINEER design, and fitted to the top end of the spindle.

A NAVAL PINNACE-TYPE OF MARINE ENGINE

By K. N. HARRIS

INCLUDED in the correspondence in a recent issue (February 13th, 1947) was a very interesting letter over the initials "ADS" about the types of engines and boilers that were used for Naval pinnaces, etc., in the hey-day of steam. Possibly the accompanying drawing and notes may be of interest.

The engine shown is a larger type and is made by Thornycrofts, with cylinders 6¾ in. and 13½ in. by 8½-in. in stroke, and runs at about 600 r.p.m. As will be seen, it is a simple straightforward job, and would make an admirable model.

As shown, it is designed and arranged to work condensing, but probably the majority of model engineers would prefer to build it as a non-condensing job, in view of the amount of work saved. In such a case the L.P. cylinder should be proportionally reduced in diameter. Assuming that the engine is to be worked at 100 lb. pressure (and there is little point in having a compound non-condensing engine working at a less pressure) the ratio between high and low pressure cylinders should be of the order of 1 to 2.35.

Herewith is the table which gives the dimensions on this basis for a series of engines :

H.P. Bore	L.P. Bore	Stroke	H.P. Steam Ports W	H.P. Steam Ports L	L.P. Steam Ports W	L.P. Steam Ports L	H.P. Ex. Ports W	H.P. Ex. Ports L	L.P. Ex. Ports W	L.P. Ex. Ports L
3/4″	1 7/32″	7/8″	9/16″	5/64″	15/16″	3/32″	9/16″	5/32″	15/16″	3/16″
7/8″	1 1/8″	1 1/2″	5/8″	3/32″	1 1/32″	7/64″	5/8″	3/16″	1 1/32″	7/32″
1″	1 17/32″	1 1/4″	3/4″	7/64″	1 1/8″	5/32″	3/4″	7/32″	1 1/8″	5/16″
1 1/8″	1 23/32″	1 3/8″	27/32″	1/8″	1 5/16″	11/64″	27/32″	1/4″	1 5/16″	11/32″
1 1/4″	1 29/32″	1 1/2″	15/16″	9/64″	1 7/16″	3/16″	15/16″	9/32″	1 7/16″	3/8″
1 1/2″	2 5/16″	1 7/8″	1 1/8″	5/32″	1 3/4″	15/64″	1 1/8″	5/16″	1 3/4″	15/32″

Note.—Port Bars = Steam Ports. Valve Cavity Depth = 0.19 × Cyl. Bore clear.
Slight variations of stroke can be made without changing anything else.

Taking back pressure of 18 lb. absolute, roughly 3 lb. gauge, the mean effective pressure referred to the L.P. cylinder would be about 36 lb. (This figure assumes that all the work is done by the L.P. piston, this being the usual method of calculating the horse-power of a compound steam engine in the absence of indicator diagrams, or in the course of design.)

As a matter of interest, the largest of the engines in the table should give about 1 b.h.p. at 1,000 r.p.m.

Now, it is not claimed that these proportions are perfect nor that after a long, comprehensive and carefully controlled and recorded series of experiments it might not be possible to improve upon them ; neither is it suggested that any departure from them will inevitably be fraught with trouble and dire disaster. They are, however, proportions which have been found to work out well in practice over a wide range of the smaller sizes of steam engines and are the results of considerable practical experience of designing, building and running such engines, not in cloud-cuckoo land, but on a commercial basis.

These engines had large bearing surfaces, which were very necessary considering the strenuous life they led, and for this reason alone form excellent prototypes for models intended for regular hard work.

For purposes of constructional convenience, it is recommended that the bar links used in the valve gear of the prototype be substituted by launch links.

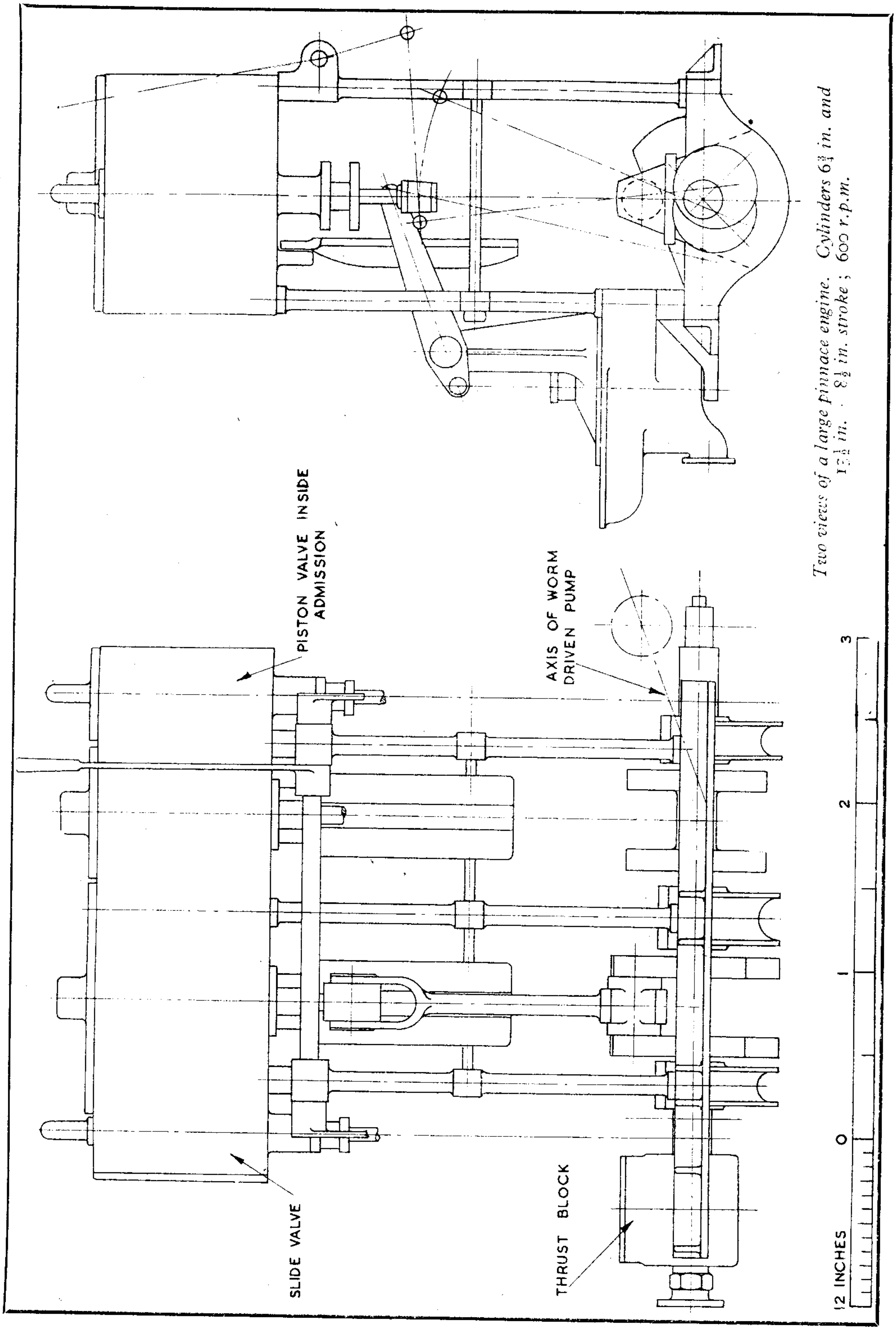
Another recommended modification is the use of a slide valve for the H.P. cylinder in place of a piston valve.

Port sizes recommended are shown on the tables.

An engine built to the general design shown, maintaining the general proportions embodied in the original, and having ports and valves of the dimensions indicated, can be relied upon to put up a first rate performance and to keep on doing so for long periods.

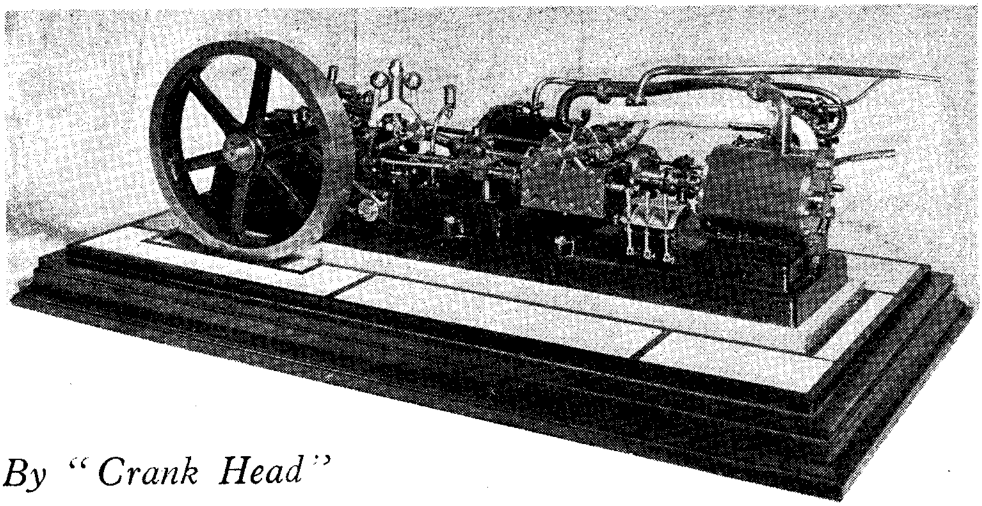
It is necessary to call attention to one most important point if reasonable efficiency is desired, and that is that the passages leading from port face to cylinder barrel should maintain a cross-sectional area at least equal to and preferably a little larger than the area of the port, and further,

(*Continued on page* 438)



Two views of a large pinnace engine. Cylinders $6\frac{3}{4}$ in. and $13\frac{1}{2}$ in. × $8\frac{1}{2}$ in. stroke; 600 r.p.m.

A Tandem Compound Engine



By "Crank Head"

IN presenting the following description of my compound tandem condensing mill engine, it is hoped that some details and methods of construction might prove of interest to readers of THE MODEL ENGINEER. An appropriate starting point would be the leading dimensions, so here they are :—H.P. cylinder, $1\frac{1}{2}$ in. bore ; L.P., $2\frac{3}{8}$ in. ; stroke, 3 in. ; designed for a steam pressure of 90 to 120 lb. per sq. in. The overall length of the model is 2 ft. 3 in. The air-pump is double-acting and is $1\frac{3}{4}$ in. bore by $\frac{5}{8}$ in. stroke. The surface condenser contains fifty-one tubes with a maximum cooling area of 210 sq. in. The circulating-pump is centrifugal, diameter of impeller 2 in., suction and delivery pipes $\frac{1}{2}$ in. diameter. The engine is not a scale model and as far as is known, is not a model of any particular engine, but simply of the type. There are no novelties in the design, excepting perhaps in the making of the various parts ; for it must be remembered this is a wartime production, and those who may have tried, know as the writer does, that supplies were not obtainable.

One of the accompanying photographs shows the home-made patterns for the only castings used ; these comprise the two cylinders, bedplates, L.P. valve-chest, flywheel and cylinder for feed-pump. The castings which, fortunately, were made a number of years ago, and forgings for connecting- and piston-rods were all that was in existence in 1943, when work on the model was begun. The crankshaft, made from a piece of $\frac{7}{8}$ in. thick flat bar, was shaped by drilling, sawing, chipping and filing, and finally by turning. Other than remarking that the job became tedious before it was completed, this detail needs no comment. It was the first component to be made.

The cylinders were next taken in hand, marked-off, bored, flanges faced and turned, and valve faces filed up. Here it may be mentioned that the ports were not cast in the cylinders, but drilled afterwards, the ports in valve faces being, of course, milled and filed up to the usual rectangular shape. The cylinder covers were next tackled ; they were all turned from solid mild steel, the finished weight of covers bears very little relation to that of the material from which they were made. Apart from the great amount of work in turning, the covers for H.P. cylinder only, call for a short description ; this will be referred to later on.

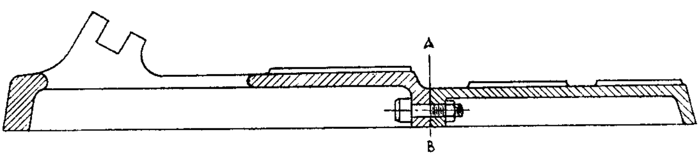


Fig. 1

The next operation was the putting together of the bed of the engine, which, in order to avoid distortion, was made in two pieces and jointed at *A*, *B* (see Fig. 1). The under-side of castings were first trued up ; the jointing surfaces were then filed up square to each other and underside of casting. This having been satisfactorily accomplished, holes were marked off and drilled, and castings then bolted together with fitting bolts, which were made for the purpose. In all marking-off operations the bottom side of the bedplates was the datum line. This method was made possible by my coming into possession of

a large piece of plate-glass $\frac{3}{8}$ in. thick, which an obliging motorist pushed out of a shop front while reversing his car during the black-out; no record is available of the shop owner's remarks when he discovered this, but he was good enough to

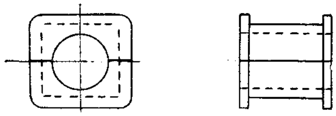


Fig. 2

present me with two large pieces of the wreckage, one of which is large enough to be used as a surface table.

The bedplate being assembled, it now became possible to find the positions of the centres of housings for main-bearing brasses, working on each side of the casting from the joint before-mentioned. These points having been obtained, the housings were carefully marked-off, sawn out roughly, then filed to shape.

brasses, a starting point for lining-up the cylinders guides, etc., became possible and the following was the method adopted:—A piece of steel (*A*, *B*, *C*, Fig. 3) was turned to fit the main bearings, and placed in the position indicated; point *A* is midway between the bearings, and points *B* and *C* on either side equidistant from *A*. The trammels were now set, and two arcs intersecting at *D* struck from points *B* and *C*; this process was twice repeated, giving points *E* and *G* a line drawn through points *D*, *E* and *G*, and produced the whole length of the bed is the centre line; method unorthodox, perhaps, but quite successful! This line is most important, and should be carefully centre-punched.

It was now possible to mark position of holes on bedplate for cylinder holding-down bolts. Holes were drilled, and cylinders placed in position, having marked the centres of bores in cylinders at each end, they were then squared up to centre line on the bedplate, and holes in cylinder feet marked off; a circular scriber was made to fit bolt-holes for doing this job. These

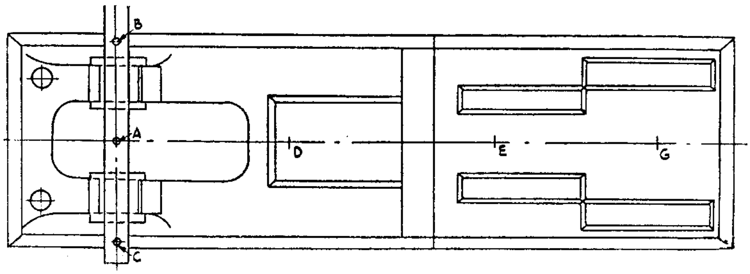
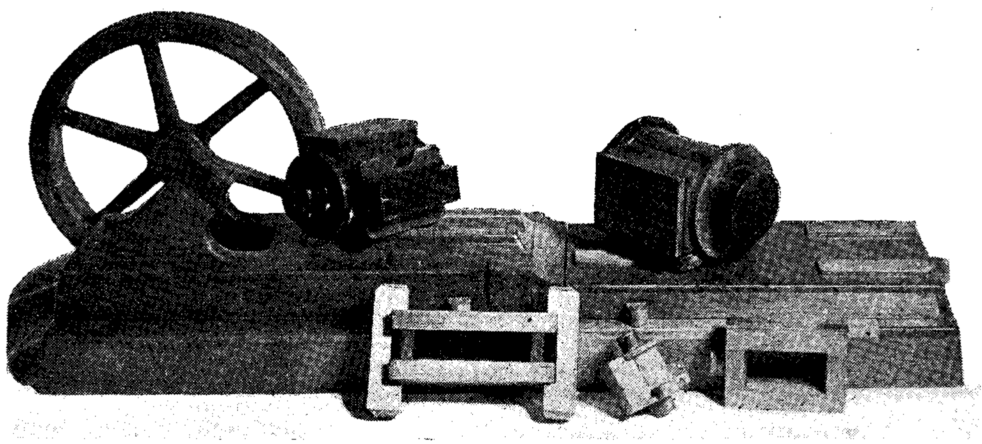


Fig. 3

The main bearings were now made (from bronze such as is used for bushings in motor-cars), square in section (Fig. 2), and fitted snugly in their housings. The making of these bearings presents no unusual difficulties, but after sweating the halves together and boring them, great care is required in the final fitting in order to retain alignment. Having fitted the main-bearing

holes were very carefully drilled, and paid a handsome dividend for the trouble taken. The holes being drilled, fitting bolts 5/32 in. diameter were then made for securing cylinders, and after drilling, tapping and fitting studs in flanges of cylinders, the latter were bolted down in position.

Attention was now turned to the piston-rod, which, apart from its flexibility due to its length,



The home-made patterns

and the enlarged conical seating (Fig. 4), and screwed portion of rod adjacent, was more or less a straightforward piece of turning. The conical seating for the H.P. piston had to be larger in diameter than the remainder of the rod to enable the piston and its nut to pass over the L.P. rod, as it was desired to have H.P. and L.P. rods of uniform diameter; reference to sketch will make this clear.

angle of 90 deg. and bolt-holes drilled at *A* and *B*. The piston-rod was now removed from the lathe, and the slipper made and fitted. This latter consists of a piece of $\frac{1}{8}$-in. sheet brass, with two pieces of brass $\frac{3}{16}$ in. by $\frac{1}{8}$ in. silver-soldered across it at *C* and *D*; the distance between cross pieces was now carefully filed to fit the crosshead; holes for securing slipper to crosshead were now drilled and counterbored to take cheese-headed

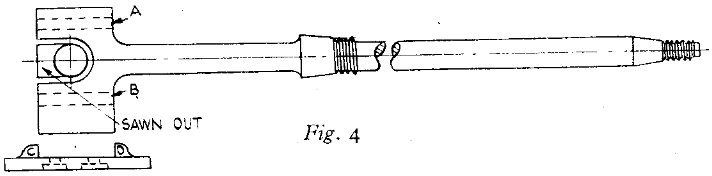


Fig. 4

The turning having been completed, and while the rod was still in the lathe, the centre line for housing of the crosshead brasses was marked off, also holes for bolts securing same. A hole was drilled in the crosshead to within $\frac{1}{16}$ in. of finished size of housing, and the remaining metal in front sawn out; the rod was now carefully set up on the vertical slide with its axis at right-angles to that of the lathe. A short boring-bar with a double-ended cutter, the length of which was the exact width of the finished housing, was mounted in the chuck; the rod was advanced to the cutter and, by manipulation of the slide-rest, carefully bored out, the result being quite satisfactory. Then the vertical slide was turned through an

screws. The slipper was now clamped in position on crosshead and, using the former as a jig, tapping holes for securing were drilled and tapped (a plug-tap came to grief in one of these holes, leaving a piece firmly wedged in hole. The removal of this piece of tap was a real headache, but a lot of " railwayese," to use an expression of our clever and respected friend, " L.B.S.C.", and a lot of patience finally saw its removal); screws were made and the whole assembled. The bottom side of the slipper was now filed and scraped up parallel with the axis of the rod, the top side filed parallel with the bottom, and the rod was placed aside, labelled "nearly completed."

(*To be continued*)

A Naval Pinnace-Type of Marine Engine

(*Continued from page* 434)

that they should be as smooth-surfaced as possible. Any easing of contours is also of advantage. Clearance volume particularly L.P., should be reduced as much as possible.

The original engines were made with the cylinders cast in one block with their steam chests and bottom covers. For model purposes it is recommended that in the smaller sizes the cylinders be cast in one block in hard gunmetal without their port faces and arranged for separate bottom covers as well as top covers. By this means, both ports and passages can be properly formed and smoothed, the port blocks being pinned and silver-soldered to the cylinders before boring and end facing.

It is not the purpose of this note to produce a complete detailed design, but rather to give the more essential data to enable the enthusiast to build a model which, given reasonable workmanship, can be relied upon to give a good performance and reasonable efficiency.

There is throughout life today a very general tendency on the one hand to spoon-feed people and on the other for people to expect to be spoon-fed. Whatever one may think of such a general outlook, nobody is likely to argue that it is good for the health of model engineering, or likely to lead to progress. If we are to have progress, then the more people who are endeavouring to improve the breed, no matter whether it is of petrol engines, steam power plant, power or sailing boats, electric, petrol, or steam locomotives, marine engines, boilers or whatever else you choose, the more likely we are to get it; always provided the people who are striving for improvement are familiar with the immutable laws underlying the design of any form of prime mover, machine or structure.

There is not much wrong with model engineering and model engineers, but too many of them are apt to sit back and accept published statements as gospel, and not to bother to get down to basic principles and reason things out for themselves. It is the writer's earnest desire to promote the spread of a more progressive and realistic approach to model engineering problems, and to provide as much basic information as possible to assist the enthusiast towards this desirable end.

It is truly said that the progress and prosperity of any nation is largely dependent on its educational standard.

The progress of model engineering is intimately bound up with the *general* level of engineering knowledge of the main body of model engineers, not with the brilliant attainments of the few.

Making Do — By "L.B.S.C."

The Tale of the Old '97

READERS who have some knowledge of American locomotive lore, will be familiar with the railroad poem: "The Wreck of the Old Ninety-Seven." Well, here is a tale of another "old Ninety-Seven," which is so far from being a wreck, that she is still going strong in this year of disgrace, 1947. It was sent by Mr. W. C. Blackstaffe, of Victoria, British Columbia, and goes to show what can be done by improvisation, by somebody who has a great yearning to build a locomotive, but is desperately short of the needful tools and material. Mr. Blackstaffe's uncle was a young fellow of eighteen years of age, when, in 1897, he contracted a bad attack of "locomotive measles." Naturally, followers of these notes don't need telling that it is a practically incurable complaint, and when deep-seated, the effect is that the sufferer (?) just has to get busy and build or run locomotives, preferably both. Curly has had it from the cradle, and will carry it to the grave. In the year mentioned, the most common type of express passenger engine in Canada was the 4-4-0, and Uncle Blackstaffe thought he would have a shot at building one to about $\frac{3}{4}$-in. scale; having no lathe didn't worry him any, and he promptly set to work to make one.

The headstock was a solid wooden block. The mandrel was a stove poker, running in babbit bearings made by pouring the melted metal into recesses in the block with the poker in place. A hardwood block on the end of the poker, acted as combined faceplate and pulley. This contrivance was driven by a ragtime foot-motor rigged up with a wooden flywheel having pieces of scrap iron nailed on to it, so as to get some weight. The only means of drilling, was an Archimedean drill, with drill bits made from tangs of old files. He had two taps and dies, $\frac{1}{8}$-in. and $\frac{1}{4}$-in.; used the kitchen table for a work-bench, and the kitchen stove for a forge. A few odd hand-tools completed the very meagre outfit, which was about on a par with young Curly's kit of some ten years earlier.

As to material, the only stuff to be readily obtained, was babbit from the local mills; the rest was scarce and hard to get, the brass tubes for the boiler being obtained from San Francisco, and having to come a thousand miles on a sailing coastal ship. Take notice, ye who moan and groan about having to go or send a few miles for the material for your boiler!

Not According to Colburn!

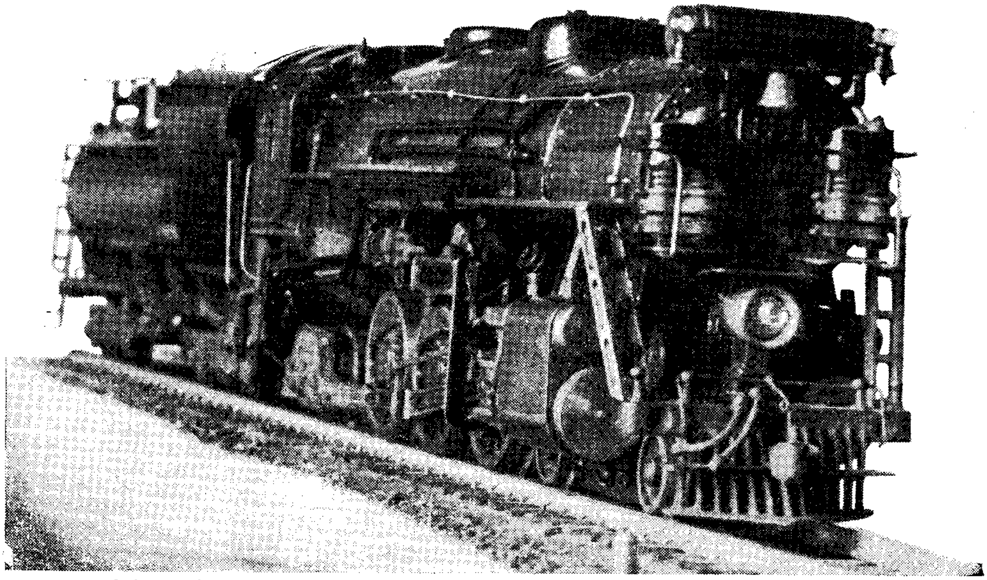
The builder began with the wheels. He made wooden moulds, cast the wheels in babbit, and bolted the castings to his "patent" faceplate with plates over the spokes, fixed with wood-screws. The turning was done with hand-tools made from worn-out square files. The axles were made from large nails, the wheels being screwed and soldered to them. The driving-axle was a brilliant bit of connivering; the four eccentrics for the link-motion were cast in place on the axle in their correct positions. The axle was flattened at the location of the eccentrics, so that they would not turn on the axle and upset the valve setting; and the axle itself was tinned, so that the babbit would hold well. It was then set upright in a hole drilled in a piece of wood and a piece of 1-in. tube placed over it, set at the right amount of eccentricity, and the right position. This acted as a mould, and the babbit was poured in and allowed to set, after which the axle was pulled out of the hole, a distance equal to width of eccentric, the tube mould shifted to next position, and another eccentric cast, repeating operations for third and fourth.

The eccentric-straps were made from strips of sheet brass, bent around like hose clips, but, in lieu of bolts, the joint was secured by a U-piece soldered on. The straps were also soldered to the eccentric-rods. The expansion-links were sawn from $\frac{1}{8}$-in. sheet brass with an ordinary fretsaw, and the slots are relieved top and bottom, as in full-size practice, so that the die-blocks shall not form ridges at each end of the movement.

Built up Cylinders

The cylinders, which are piston-valve type, are built up, and are 1-in. bore and $1\frac{1}{2}$-in. stroke. The bores are made from fishing-rod ferrules, which are thin brass tubes, true and polished, with plate flanges soldered on. The valve-liners are made same way, the diameter of the valve being $\frac{9}{16}$ in., with $\frac{3}{8}$ in. travel in full gear. Studded glands are used, the studs being the screwed ends of cycle-spokes, the nipples being filed to the shape of nuts, and the glands made from pieces of tube with oval flanges soldered to them. The piston-rods are pieces of $\frac{1}{4}$-in. brass-plated curtain rodding, the pistons being made of babbit cast on and turned in place on the rods.

The complete cylinders are fixed by flanges to the cast babbit smokebox saddle, which has steam and exhaust passages drilled in it. Guide-bars, crossheads, and guide-yokes are all built up from sheet metal and soldered; in fact, the amount of soldered work in the job would have delighted the heart of my old friend "Copper-Bit," but it must be remembered that the worthy and painstaking builder had no other means of making his joints. Another intricate bit of soldering was the pilot, or cow-catcher; the frame is bent up from a piece of tin, the usual U-shape, and all the bars separately soldered to the pilot beam, which is also made of tin. The frames are cut out of $\frac{1}{2}$-in. by $\frac{1}{8}$-in. steel, and the axles are not sprung, but just run in ordinary plain bearings; this construction is rather light, but it answered all right for the amount of stress it had to withstand under the original conditions of working.



¼-in. scale "O" gauge 4-6-4 steam loco. complete with "blobs and gadgets"

Boiler

The boiler is of the correct locomotive-type, and a pretty accurate copy of the boilers of the full-size locomotives, as far as external appearance is concerned. It is of the wagon-top pattern, with a 4-in. barrel, rising about 1¼ in. to the crown of the wagon-top firebox wrapper. The inside firebox is very deep, the grate being only 1¼ in. above rail level, with a 1-in. ashpan below that, the ashpan being fitted with a working damper. The grate is 3 in. wide by 5 in. long. The barrel contains six ⅜-in. brass tubes approximately 10 in. long; there are no superheater flues, superheating being practically unknown in those days. There is a poppet-valve throttle in the dome, operated by the usual bell-cranks and rodding. The smokebox is double, the outer casing being added to prevent blistering of the paint. The backhead has the usual assortment of fittings on it, including a three-cock water-gauge, throttle- lever, blower-valve and blowdown valves or test cocks; and there is a "Johnson bar," or reversing-lever, in the cab, close handy. All the joints of the boiler are riveted and soldered; there are 70 stay-bolts in the firebox, all hand-made, and they are nutted inside and out, the 140 nuts all being cut from ⅛-in. sheet brass, drilled and tapped by hand. What about that little bit, ye of the impatient souls? The working pressure is 40 lb. per sq. inch, quite respectable for those days, when it was generally thought to be impossible to obtain more than 30 lb., as you couldn't get the heating-surface. It was not realised that it is firebox *temperature* that does the trick!

Tender

The tender was made of tin throughout, and soldered up, including the arch-bar truck frames. The wheels were turned from hard wood, and are mounted on wooden axles, each of these having a nail fixed in each end to act as journals. This evidently points to the builder becoming a bit enthusiastic and wanting to get the engine on the road as soon as possible, otherwise he might have used the same material as for the driving-wheels and axles, *viz.*, cast babbit wheels on long nails. However, as the locomotive was originally intended to run on a wooden railway, the wood wheels did their job all right. The engine steamed very well, and ran either way with even beats, giving great satisfaction to its ingenious and painstaking builder.

Rejuvenation!

The engine eventually came into the hands of Mr. Blackstaffe, and he was so tickled with the old girl, that he set to work to bring in a little bit of modernisation, and see what she could do. To enable her to run on an ordinary steel track, the cast babbit wheels were replaced by cast-iron wheels on new steel axles, the driving-axle carrying four steel eccentrics with proper straps. Originally, there was no means of adjusting the valves except by melting the soldered joints between eccentric strap and rod, and shifting the rocker arm; so Mr. Blackstaffe made the new eccentric-rods adjustable, where they joined the straps. The brass cylinders were honed out on a machine used for honing our automobile wrist-pin bushes, and new pistons and valves were fitted. These were made of babbit as originally, our friend being chary of putting any harder material in the soft brass liners.

Incidentally, mention of that, takes me back to childhood again, when young Curly got hold of a bit of telescope-tube and made two oscillating cylinders out of it, long before I got the little lathe. The two pieces of tube for the cylinders were cut off, and the ends filed square with the bore, steam blocks and flanges

being soldered on. The pistons were cast in white-metal, which was once a paper weight. A piece of the tube formed the mould, placed on a bit of wood with a French nail standing up in the middle of the tube. The metal was melted in a discarded enamelled-iron cup, over the kitchen fire, and poured into the tube, covering the head of the French nail piston-rod, which was thus fixed in the piston "for keeps." When cool, the bit of tube was cut off, and the piston worked in its proper cylinder by hand to ease it; these pistons were practically frictionless after being run in, and with the low pressure supplied by a tin can boiler, they were perfectly steam tight.

Though Mr. Blackstaffe didn't say so in his letter, I presume his new babbit pistons were turned and packed. The frames of "Old 'Ninety-Seven" were stiffened up with some cross braces, a passenger-car made, with the wheels running on old ball-bearings, and 50 feet of $\frac{1}{4}$-in. square black iron laid down for a railroad, the gauge being 4 in. The results were well up to expectations. Steam can be raised in from 5 to 8 mins., depending on the fireman, air being pumped into the boiler by aid of a tyre-pump, and the engine's own blower being used. She will start two adults, total weight 330 lb., exclusive of the four-wheeled flat car, on rough rails on a slightly rising grade (just enough to coast back with steam shut off) with her modest 40-lb. pressure. Shunting one adult back and forth is easy work and she does it quite lively. She will pull one adult on the level with only 15 lb. With ordinary care in firing, steam pressure is fully maintained, even if run in full gear with wide-open throttle. Originally she had no steam-gauge, but Mr. Blackstaffe fitted one when he did the repairs. The engine has a good blast, but does not throw much fire from the chimney.

The coal in British Columbia is sooty and tarry, and the tubes rapidly become choked, but by using a tube scraper, made like an ice-cream cone on the end of a rod, and using it whilst the boiler is still hot, the residue can be removed before it sets. The beats are even and sharp; the valves were set under air pressure, and the cut-offs are equal to within a movement of $\frac{1}{16}$ in. on the rim of the driving wheels. When starting a heavy load, the frames twist under the shouldering action of the cylinders, which throws the beats out a little; but once under way, they are quite O.K., though there is not much chance of notching-up closely on a line only 50 ft. long. The top of the high firebox forms an effective combustion chamber; despite the poor coal, the fire burns very brightly and the smoke is nearly all consumed. Up to the present, no trouble has been experienced through leakage at the soldered joints. Mr. Blackstaffe says that, considering the conditions under which the engine was originally built, and she is now half-a-century old, she is a proper masterpiece; and your humble servant agrees. The old saying, "Where there's a will, there's a way," is very true.

Two Uncommon Jobs

Turning to our worthy friend's own efforts, about fourteen years ago there appeared in these notes a picture of a Chesapeake and Ohio locomotive, which had so many accessories tacked on to her (she seemed to be carrying everything except a turntable) that I nicknamed her "Queen of the Blobs and Gadgets." At that time Mr. Blackstaffe had a yearning to build a $3\frac{1}{2}$-in. gauge 4-6-0, but said he couldn't afford it, so decided to build something special in gauge "O" instead, on the old "half a loaf being better than none at all" system.

Then he happened to meet somebody who had a super-detailed electrically-driven 2-10-4, adorned with as many blobs and gadgets (all dummy, of course!) as the "Queen" mentioned above; and thought it would be a good idea to build a steam-driven "Queen" complete with all the blobs and gadgets as per illustration. The owner of the "Milly Amp" outfit said it couldn't be done; and even so, steam engines were messy, uncontrollable, and could not pull a load, also nearly poisoned everybody with alcohol fumes. He had only seen the usual tinplate toys, and did not believe there was anything better in the steam line. "All right," said Mr. Blackstaffe, "I'll build the steam engine; and what's more, I'll build it to scale with all the blobs and gadgets." Build it he did, with only a couple of photographs as a guide.

As a gauge "O" valve-gear "to scale" wouldn't stand up to actual work for any length of time, our friend actuated his valves by a pair of loose eccentrics, and the outside valve-gear is dummy. The cylinders were carved out of a solid block of cast-iron and are $\frac{1}{2}$-in. bore and $\frac{7}{8}$-in. stroke; Mr. Blackstaffe says he has made several marine engines with cast-iron cylinders, and had had no trouble with rust. Then came a spot of bother, for the smallest end-mill he had was $\frac{1}{8}$ in., and no taps and dies smaller than $\frac{1}{8}$ in. by 40, so everything had to be wangled to bring these in, and yet keep to "scale." The slide-valves are in a single steam-chest which forms the smokebox saddle. The steam ports are $\frac{1}{8}$ in. by $\frac{5}{8}$ in., and the exhaust $\frac{3}{16}$ in. by $\frac{5}{8}$ in., but they are milled only $\frac{1}{16}$ in. deep, and the steam ports are connected to the bores by four 7/64-in. holes. The valve travel is $\frac{1}{4}$ in., the ports not being fully opened on the steam side, and the cut-off is about 85 per cent. The exhaust passage is drilled $\frac{3}{16}$ in. and the blast-nozzle is 7/64 in. diameter.

Too Much of a Good Thing!

In my little dissertation awhile ago, about combustion chambers and so forth, I said that the firebox, tubes, grate area, etc., should be properly proportioned to the boiler, and the result would be success. In an attempt to make a fast steaming boiler, it is an easy matter to provide more heating-surface than is necessary for the amount of water carried, with the result that the plates overheat, and the water dances about on them like a teaspoonful of water dropped on top of a red-hot stove. This is exactly what happened in the case of friend Blackstaffe's first boiler. The barrel was 2 in. diameter at the firebox end, tapering to $1\frac{3}{4}$ in. at the smokebox end. It contained two $\frac{3}{8}$-in. superheater flues, five $\frac{5}{16}$-in. tubes, and a combustion-chamber

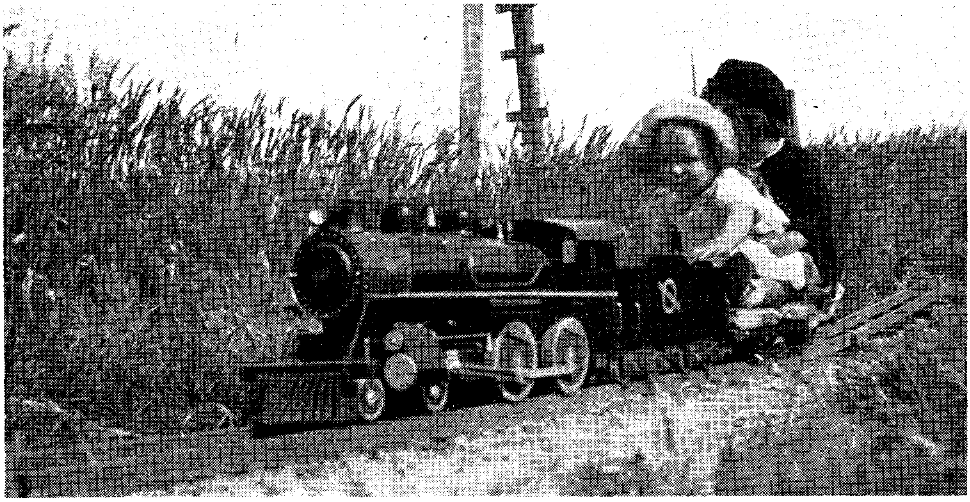
3 in. long, with six $\frac{1}{4}$-in. water-tube struts. The superheater element was a U-loop going back to the firebox. The grate measured $1\frac{5}{8}$ in. by $1\frac{7}{8}$ in., and the height of firebox from grate to crown-sheet was $1\frac{1}{2}$ in. The heating surface was approximately 60 sq. in. Just fancy that on a gauge "O" boiler; it was more than specified for $2\frac{1}{2}$-in. gauge boilers of the "smokebox-condenser" pattern! The boiler certainly steamed, and enabled the engine to pull its builder easily, but you couldn't keep any water in the blessed thing! Fired with charcoal, the inside was nothing but bubbles, which did not settle down until the water dropped below the crown-sheet.

Our worthy friend thought that, maybe, the water-tubes were playing a fountain into the dome, so he made another similar-sized boiler, left out the water tubes, and put in only three $\frac{3}{8}$-in. tubes in place of the original nest. This reduced the heating-surface by half; the superheater did not go into the firebox, but formed a coil inside the combustion-chamber, entering and leaving by the two upper tubes. A baffle, with a gauze strainer around it, was placed under the dome, to keep splashes from going down the steam pipe. The heating-surface of this boiler being proportionate to the amount of water carried, it was a success. Even on house coal, it will gain steam on a wide-open throttle, with the driving-wheels braked to a "scale eighty," the exhaust being extremely snappy, and blowing sparks to a height of 3 ft. from the top of the chimney.

Conversion to Oil Firing

Friend Blackstaffe says that, at this stage, it was evident that the engine would be a job to fire on the run, with the tender coupled up, so he made a small blowlamp, set it on the tender chassis and arranged it to blow in the firehole. This gave excellent results; no stopping to fire, and much higher superheat, due to the flame playing direct on the coil. On a passenger-hauling test, with a driver weighing nearly eleven stone, track only 20 ft. long, engine on "scale" rails, and car on $\frac{5}{16}$-in. square black iron, the engine covered 1,500 ft. in 17 mins. running time, and used 5 ozs. of water.

The tender was then finished off with an oil tank measuring $2\frac{1}{2}$ in. by $2\frac{1}{2}$ in., which holds enough for two hours' run. The burner is Carson type with the addition of an adjustable jet, and has never given any trouble. Starting off with 40 lb. pressure, it will rise to 60 lb. in two trips up and down the 20-ft. track, and the safety-valve is then kept busy. The coil superheater soon burnt out, and was replaced by three spearhead elements, one in each tube, which are still there. The job was finally finished and painted in time for the Y.M.C.A. Hobby Fair, in 1942, at which she did a spell of passenger hauling. She was at work hauling kiddies from 6 to 9 p.m. on the Friday, and from 2 to 5 and 6 to 9.30 p.m. on the Saturday, the only breaks being a few minutes to refuel. Our friend says his legs ached walking up and down the 20-ft. track, whilst the kiddies were riding. He also says the owner of the "Milly Amp" outfit got a terrible shock when he saw a fully-detailed engine carrying all the "jewellery" her big sister wears, actually working by steam, hauling big loads, keeping quite clean and free from fumes; had a drive himself, and pronounced her perfect!



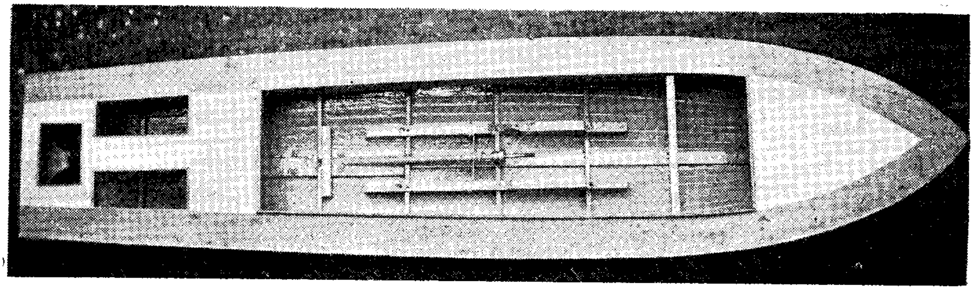
Wooden 4-4-0 loco. on kiddies' gravity line

The Kiddies' Own Railroad

The other uncommon job carried out by our worthy Canadian friend is a gravity railway which can be operated by the children themselves, as shown in the picture. The smart-looking realistic 4-4-0 is made of wood, and driven by gravity. All the youngsters have to do, is to push it to the upper end of the track, climb aboard, and coast down, without the slightest danger. Well, here's hearty congratulations to Mr. Blackstaffe on all his work, and many thanks for letting us have such interesting details.

Constructing Model Power Boats

By G. Woodin



Plan view of a model motor torpedo-boat

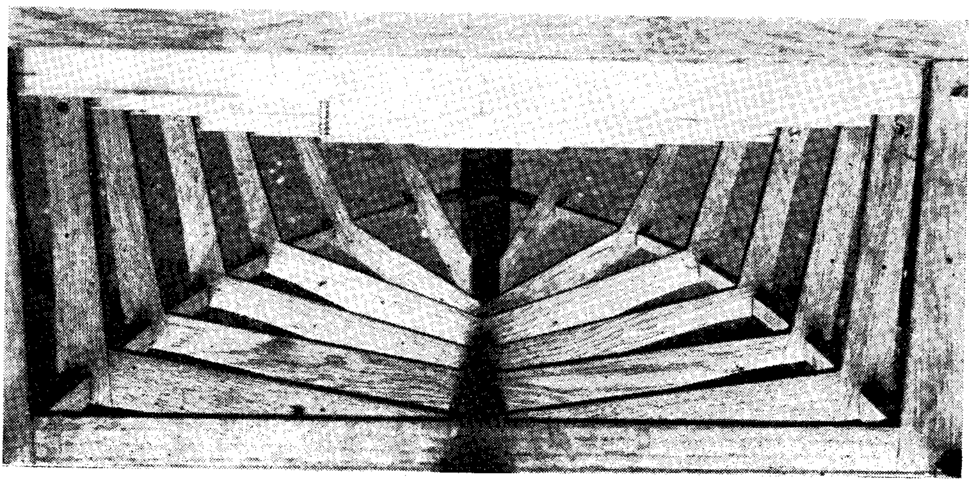
THE accompanying photographs show the construction and finished hull of model high-speed launches in the process of building.

The model shown in plan view was one of Vosper's motor torpedo boats, and so the hull follows these lines. It is 4 ft. 4 in. in length, with a beam of 12 in., and is built up of ten ribs of ¼-in. ply and stringers of ⅜-in. square birch. I must point out that the two photographs showing the framework are not of the same boat as the one I am describing, although both boats were built by me and the construction methods are the same in both cases. All joints were screwed and glued with casein glue and the finished frame was planked with deal strips ½ in. wide and a full ⅛ in. thick, butt-jointed together with plenty of glue.

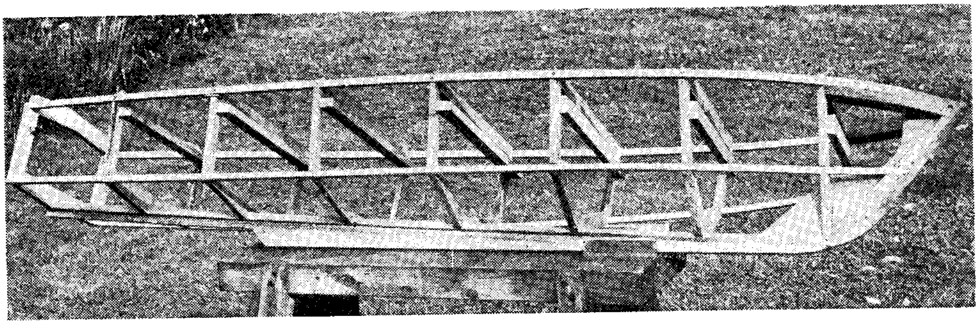
At this stage I wrote to the British Power Boat Co. as I thought the small cabin of a motor-torpedo boat would not leave much room for access to the engine, and they very kindly furnished me with drawings and photographs of a 47 ft. 6 in. high-speed yacht built by them. Although my hull differs slightly from their drawings, the superstructure and deck lines are quite adaptable to my hull, so all the deck openings were built and the decking fitted.

As in the British Power Boat Company's drawings, the outer edge of the deck is made from sheet mahogany, which overhangs the hull ¼ in. all round, and is shaped to give a rounded beading. The rest of the decking is filled in with deal planks.

While decking the hull, brass screws and casein glue were used, and when the glue was set



Showing the framework of ribs and stringers in a model power-boat



Another view of the framework

the screws were removed and the holes filled in with mahogany pegs which, when smoothed off level and polished with the deck, will be almost invisible.

The photographs show that there will be no difficulty whatever in getting at the engine ! !

At the time of writing, the finishing touches are being done to the cabin and I hope to be able to furnish details and photographs of the finished boat very shortly.

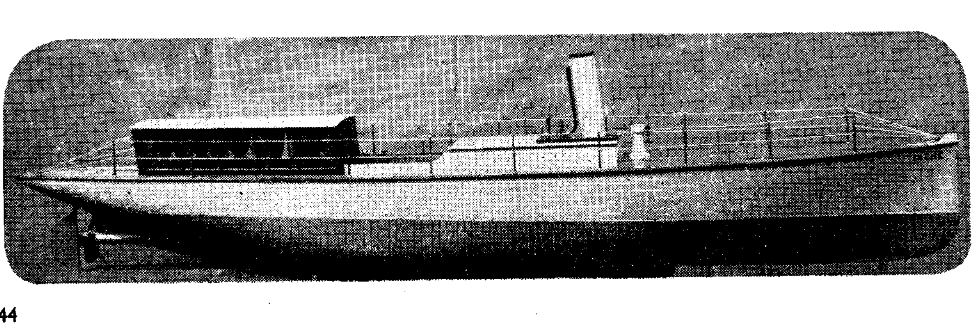
A Power Boat of 50 Years Ago

As a further commentary on the model launch, built by the late Mr. Ferreira, to which reference was made in " Smoke Rings," in our issue for March 13th, the photograph of the actual launch which we reproduce herewith will be of interest to our readers. Although the type may seem to us to be rather old-fashioned, it has a beauty and a smartness which cannot be denied. The workmanship so far as can be judged by the photograph, and knowing Mr. Ferreira's standard, is of a high order, and altogether the model deserves to be put on record.

The hull is made of white pine, bread and butter fashion, and is 5 ft. long by 10-in. beam. The deck cabin is built up in full detail and has correctly glazed windows.

During its long life, the launch has had three different power units. The first was a single cylinder slide valve engine with a double tube coal-fired boiler. The second installation had a flash type boiler and a double cylinder slide-valve engine. For the third power unit Mr. Ferreira reverted to a coal-fired boiler, but made it to larger dimensions, and the engine was changed for a compound. A comparison between the performances with each of the three power units would have been very interesting.

Mr. J. E. Jane, of Acton, who is a relative of the builder, and who very kindly supplied us with the photograph and the particulars, writes : " The performance, I understand, was extremely good. On a few occasions it ran for some distance on the Thames at Henley-on-Thames and proved itself capable of towing a skiff containing Mr. Ferreira and two more people for a distance of one mile. Incidentally, the steering throughout these performances was done by remote control."



A FAMOUS MIDLAND ENGINE OF 1886

By W. TUCKER

As a counterblast to this age of streamlined dirt and ugliness on our "great" railways, the Great Western excepted, I am offering a short history and a few notes on the famous Midland Railway express engine *Beatrice*, in the hope that someone may be stimulated to forgo the "infernal" Pacific or paralytic eight-coupled abortion and produce (with apologies to "L.B.S.C.") a real little Live Steam *Beatrice* for 3½-in. gauge, or "inch scale," to gladden our sad eyes in this so-called atomic age of progress. One would almost be lead to believe that our railways now vie with one another, always excepting the G.W.R., in producing locomotives more suggestive of the productions of a certain famous futurist sculptor rather than real engines, whereas in the age of *Beatrice*, the then locomotive superintendents vied with one another in combining "pull and go" with beauty of line and elegance of proportion. Perhaps, after Charles Beyer, the greatest artist of them all was Mr. S. W. Johnson, of the Midland Railway, and perhaps the most beautiful of all the splendid engines produced by Mr. Johnson was *Beatrice*.

The last of a batch of ten 7 ft. 0 in. coupled express locomotives, built at Derby, in 1886, *Beatrice*, so named in honour of Princess Beatrice, was exhibited at the Saltaire Exhibition, where she was awarded a Gold Medal, the first of three of Mr. Johnson's engines to gain such a distinction. The "1740" class of 7 ft. 0 in. engines to which *Beatrice* belonged, was designed by Mr. Johnson to succeed the "1667" class of 1884. These engines, the "1667" class, had several notable features, such as 19-in. bore cylinders, and Joy's valve-gear, being contemporary with James Stirling's 7 ft. 0 in., 19-in. cylinder four-coupled express engines for the S.E.R., recently described in THE MODEL ENGINEER. Ahron's tells us that, although good runners with light trains, the "1667" class easily ran out of breath.

Johnson did not make the same mistake again. *Beatrice* had cylinders 18 in. diameter by 26-in. stroke, but the working pressure went up to 160 lb. per sq. in., an increase of 20 lb. over the preceding engines, and the Joy's valve-gear was replaced by the Stephenson's link motion. These engines, incidentally, were the earliest on the Midland to have steel boilers. The heating surface was small, but that did not prevent the engines being amongst the most successful of their day.

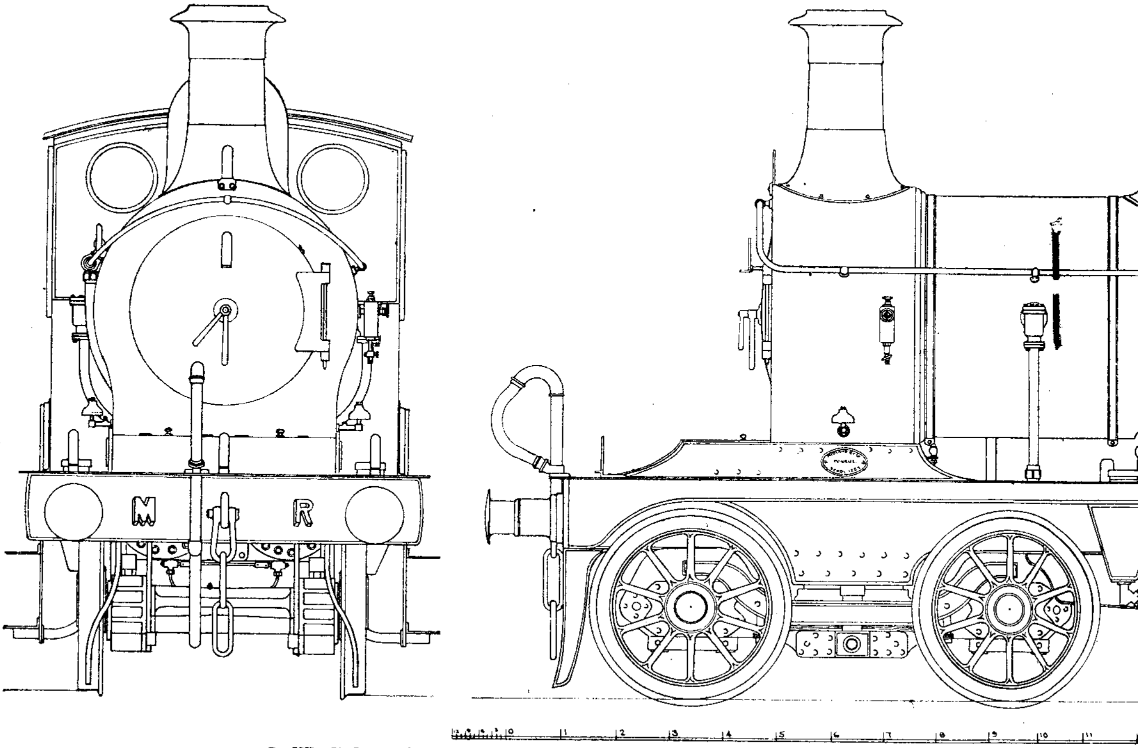
Outwardly, *Beatrice* bore all the beautiful Johnson hallmarks. Gracefully-curved splashers, elegant built-up chimney of Johnson's first style; small cab; all curves, "dome salters" and a brass "coffee pot" over the firebox. Lubrication was looked after by a displacement lubricator on the smokebox side, and two small mushroom-shaped affairs low down on the wrapper plate. The underhung injectors behind the cab steps delivered into two brass clack-valves placed on the front ring of the boiler barrel *via* polished copper pipes. Steam sanding, then newly invented (the earlier engines of the class had ordinary drop-sanders) was used; a polished copper pipe and fittings distinguished *Beatrice's* sanding gear, can you imagine that even on an exhibition engine of those days!

Brakes were steam-operated on engine and tender (in conjunction with the usual tender hand-brake), the vacuum ejector of Johnson's second type being placed on the driver's side near the smokebox. A combined steam and vacuum application valve was used in the cab. All these details are still in use on L.M.S. engines today, except that Stanier introduced the G.W.R. type of ejector on the firebox side; not bad, sixty years' run with only detail improvements.

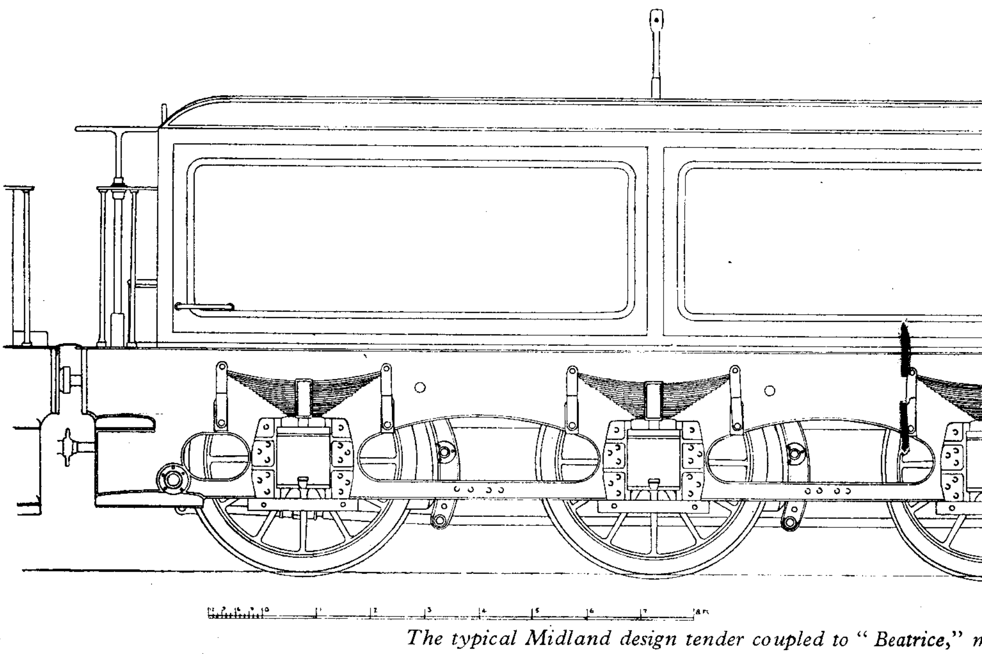
The 1¼-in. thick plate frames were solid from end to end, Johnson not then having introduced the spliced joint at the motion-plate, still to be seen on all ex-M.R. 4-4-0 and L.M.S. "Compounds" and "Class 2" 4-4-0s. The bogie was of the Adams sliding type, and of a design still used by the L.M.S. until the advent of Stanier in 1932; also, not a bad record as the first Johnson bogie came out in 1876!

Johnson's tenders were in advance of most others at that time, having the springs under the platform above the axle-boxes, not as in the earlier 4-4-0s behind the frames and very inaccessible. The perfection of the modern tender owes a lot to Johnson. On the Midland this type of six-wheeled water-cart was used until the bogie tender was introduced in 1900, and subsequently reverted to by Deeley, but with flat sides, a type perpetuated by the L.M.S. as standard until the now-familiar high-sided variety was introduced by Stanier in 1934. Johnson's tender of 1885 was provided with the pulley and guide for an early form of communication-cord; also, at the rear, or train end only a screw coupling was provided, no hook being used. The tool-boxes were at the back near the filling-hole; later they transferred to the engine end. Altogether a very satisfactory piece of work; Johnson's tender, matching the engine, and providing a great contrast to contemporary L.N.W.R. tenders or the clumsy coal-wagons attached to Fletcher's N.E.R. engines.

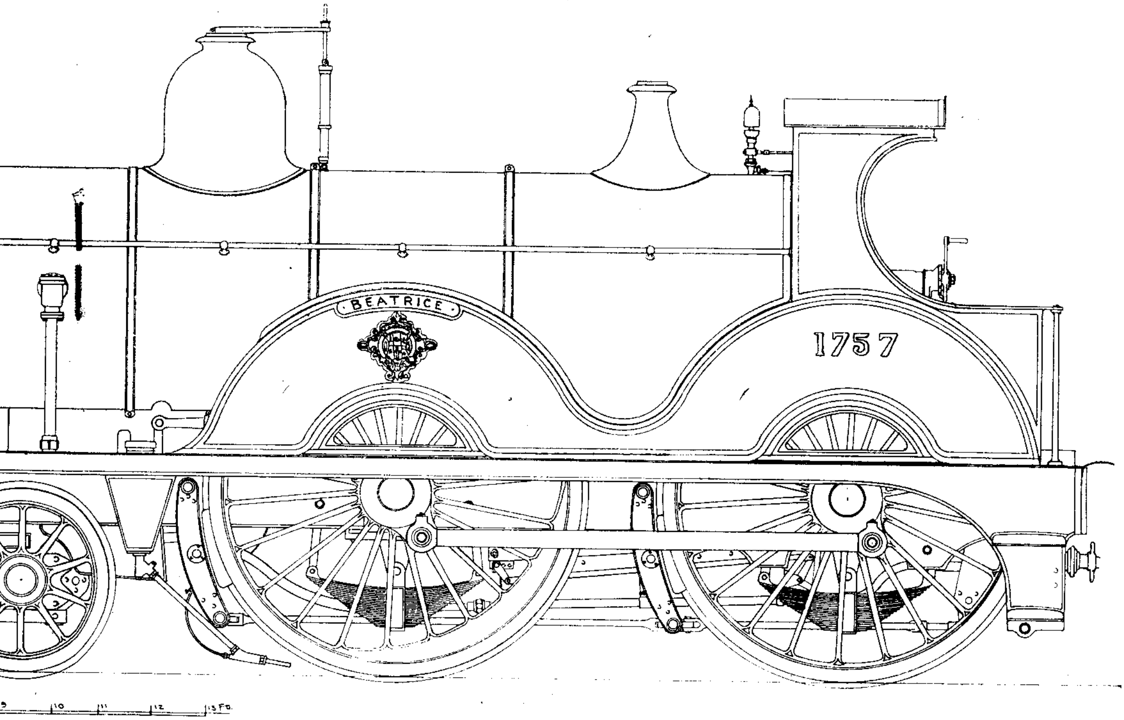
It is a great pity that colour photography had not been invented in 1885, as *Beatrice* must have looked as "pretty as a picture" at the exhibition, where she gained her gold medal; she was also the first of the only two engines on the Midland Railway since very early days, to carry names, *Princess of Wales*, a 7 ft. 9½ in. "single," the Paris Grand Prix engine being the only other. The livery of Derby red and black, and yellow lining, must have looked superb. An early photograph, probably taken when the engine was ready for, or actually at the exhibition, shows that *Beatrice* was probably specially finished, as there is a complete absence of rivet or bolt heads showing on the engine or tender



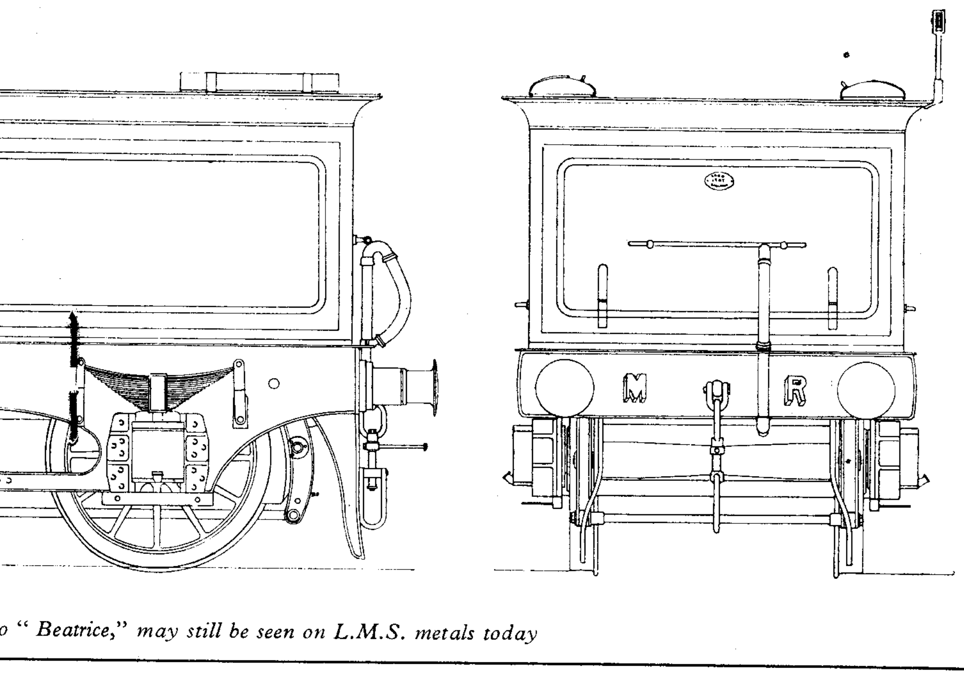
S. W. Johnson's beautiful 7 ft. 0 in. four-coupled express locomotive, " Beatrice," for the M



The typical Midland design tender coupled to " Beatrice," n



trice," for the Midland Railway, gained a Gold Medal at the Saltaire Exhibition of 1887



o " Beatrice," may still be seen on L.M.S. metals today

framing, as compared with other engines of the same class. Under the neat brass nameplate, a magnificent reproduction of the Midland coat-of-arms appeared, whilst on the cab splasher the number was done in raised brass figures. The initials "M.R." do not appear on the tender in the photograph referred to above, so I have not shown them on the drawing, which I hope shows *Beatrice* as near to her original condition.

To conclude, *Beatrice* had a long and honourable career on main line express trains, and later on the St. Pancras-Tilbury expresses. Mr. Deeley re-boilered her about 1905 with his large type "H" boiler and fitted a more modern cab, etc., and re-numbered her "377." Later on, a still more drastic re-build was undertaken by Sir Henry Fowler, when "377" emerged as a "Class 2" superheater engine. Very little of the original engine can have survived this second metamorphosis, beyond the tender and, perhaps, the bogie.

Well, locomotive fans, what about a $3\frac{1}{2}$-in. gauge *Beatrice*. Wouldn't it be lovely to see and hear the "dome salters" sizzling, and watch the big driving wheels flashing round until the lining of the spokes disappears into a blurr? By the way, don't forget the little yellow lines at the heel and toe, as it were, of each spoke.

Beatrice had wrought-iron wheels with rectangular section spokes, so please don't use modern type wheels with great heavy crank bosses and elliptical spokes! Here are a few useful dimensions.

Cylinders, 18 in. dia. × 26 in. stroke.
Centres of cylinders, 2 ft. 4 in.
Length of connecting-rod, 6 ft. $2\frac{3}{4}$ in.
" " eccentric-rod, 4 ft. $3\frac{7}{8}$ in.
Driving wheels, 7 ft. 0 in. dia.
Bogie wheels, 3 ft. 6 in. dia.
Coupled wheel base, 8 ft. 6 in.
Bogie " " 6 ft. 0 in.
Total " " 21 ft. $6\frac{1}{2}$ in.
Centre line of boiler above rail level, 7 ft. $3\frac{3}{4}$ in.
Dia. of boiler barrel, 4 ft. 1 in.
Dia. outside boiler lagging, 4 ft. 7 in.
Length of boiler barrel, 10 ft. 6 in.
" " firebox outside, 5 ft. 11 in.
Height to top of chimney, 13 ft. $1\frac{5}{16}$ in.
Width over platforms, 7 ft. 7 in.
" " splashers, cab, 6 ft. 6 in.
Length of buffer beam, 7 ft. 5 in.

Colour Scheme

Boiler, frames, splashers, cab, wheels (except for tyres and axle ends), tender frames: Derby red or Midland lake, edged with black and lined yellow.

Tender panels and back: red as above, but with broad black line inside panel, with a yellow line either side.

Boiler bands: black, edged yellow line. Black line edged yellow, also round dome base.

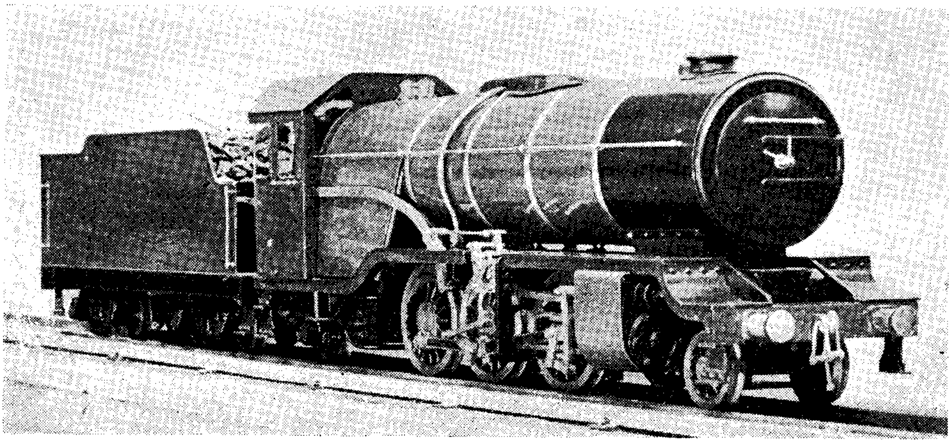
Buffer beams: vermilion, edged black lined yellow.

Buffer sockets: black band at edge, lined yellow.

Inside of cab: buff or stone colour.

A Free-Lance $2\frac{1}{2}$ in. Gauge Mixed-Traffic Loco.

By P. T. Atkinson



LEADING PARTICULARS:—Cylinders (2): $\frac{13}{16}$ *in. bore* × $1\frac{1}{8}$ *in. stroke. Driving and coupled wheels,* $2\frac{3}{4}$ *in. dia. on tread. Pony and trailing truck,* $1\frac{5}{8}$ *in. dia. on tread. Valve-gear,* "*Baker.* Boiler: $3\frac{1}{8}$ *in. dia.* × 16 *s.w.g. barrel, with* 14—$\frac{3}{8}$*-in.* × 22 *s.w.g. and* 1—$\frac{5}{8}$*-in.* × 22 *s.w.g. tubes. Heating surface,* 190 *sq. in. Grate area,* 14.6 *sq. in. Working pressure,* 90 *lb. sq. in. Maximum load hauled, approx.* 650 *lb. Lagging, planished steel. Cylinder lubrication, mechanical pump. Boiler feed, twin axle-driven and one hand-operated pump*

The Simple "D" Slide-Valve

By A. H. Poole

THIS article is primarily intended for those model makers who prefer to design their own steam engines. I have always gained much pleasure and satisfaction from making an engine I have designed myself, for then the model is a result of my efforts from its very earliest stages. I found, when designing my first engines, that I had great trouble with valves and valve gears. I was not too sure of the various terms used, the advantages and disadvantages of things known as lap, lead, etc. Even when the job was finished, valve setting was difficult, for I had not the complete knowledge necessary.

The D-shaped slide-valve, worked by a single eccentric is considered in this article because of its relative simplicity. The valve works in a steam chest and is held in place by the pressure of steam in this chest. It can be seen in Fig. 1. that any steam which does pass between valve and valve face escapes into the exhaust passage and so to the atmosphere, condenser, or if a compound engine, into the next stage of expansion. The various positions of the slide valve are obtained by an eccentric on the crankshaft 90 deg. ahead of the crank, and is conveyed to the valve by the eccentric-rod, crosshead and valve-spindle. In the case of a reversing engine, separate eccentrics are used for ahead and reverse, or by some other means, such as a slip-eccentric.

There are various terms used when discussing valves, and it is essential to thoroughly understand their meaning. When the piston is at either extreme end of its stroke in the cylinder the term *dead centre* is used, top dead centre being the name for the position of the piston when farthest away from the crankshaft, bottom dead centre for the other end position. The eccentric, arranged to be exactly 90 deg. ahead of the crank, places the valve so that exhaust has just stopped and steam is about to enter the cylinder at top dead centre. This means that there is no steam in the cylinder to cushion the reversal of the piston, which has been moving rapidly in the upwards direction and must now move downwards. This uncushioned reversal of a mass obviously will cause unnecessary vibration and extra stresses on the reciprocating parts. The cushion effect is obtained by allowing steam to enter the cylinder just before the piston reaches dead centre. The shock of reversal being partially taken by the steam thus allowed to enter. The valve, already on its way to allow steam to enter the cylinder, ensures that the engine is not starved of steam because of late steam entry. This alteration in valve movement

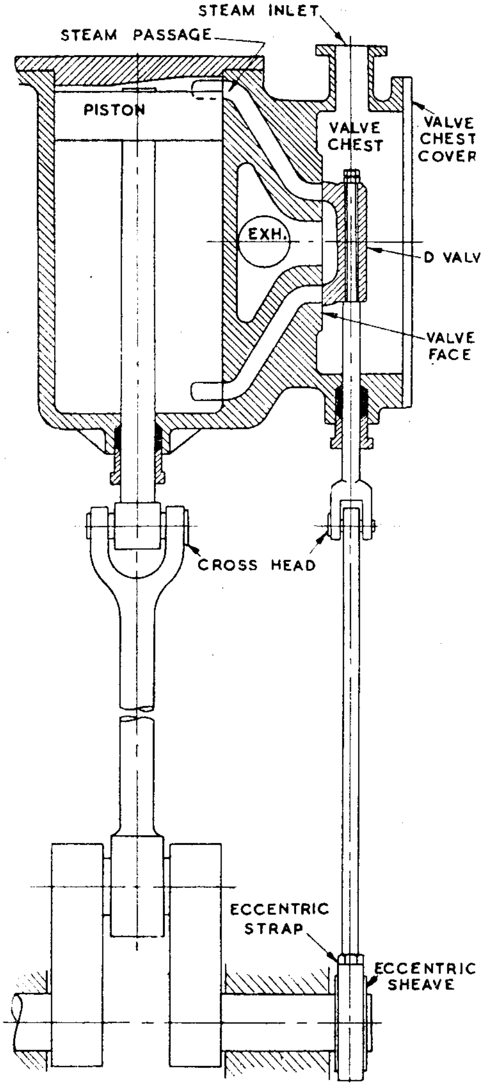


Fig. 1

is achieved by advancing the eccentric a few degrees more than 90 deg., which causes the valve to be open an amount called *lead* at the top dead centre. The amount of lead being the distance indicated in Fig. 2, the piston being at top dead centre.

We have now got a valve which will cushion the reciprocating weights on reversal; but if the movements of the valve are considered, it can be seen that the steam is not allowed to do all the work of which it is capable. Starting with the piston on top dead centre, and the valve giving a predetermined lead (Fig. 2), the piston moves down the cylinder to just before half stroke, and the valve moves to full opening to steam (Fig. 3). The piston continues to move

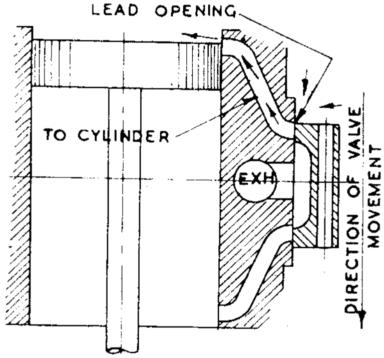


Fig. 2. D-valve, showing lead on top of valve

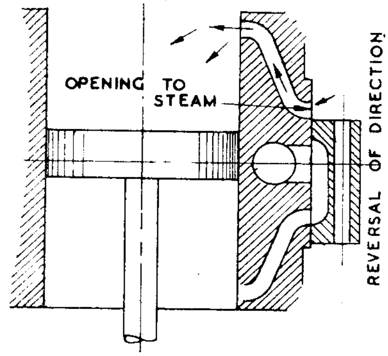


Fig. 3. Valve, showing full opening to steam to top side of piston

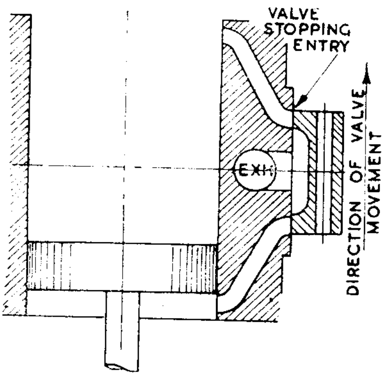


Fig. 4. Cut-off. No steam entering or leaving top or bottom side of piston

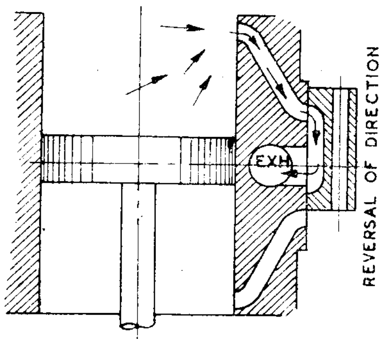


Fig. 5. Top side of piston open to exhaust

down, the valve reverses its direction to reach a position where steam is stopped further entry (Fig. 4). This is when the piston arrives nearly at bottom dead centre, and is called the *cut off* position. The valve is now at mid-position, any further movement of the piston causes the valve to open to exhaust (Fig. 5). It is only at mid-position the steam is trapped in the cylinder. The piston, continuing, causes the valve to move to full exhaust, reverse direction, and close again, just before the piston reaches top dead centre. On gaining this position, the valve is open to lead again, the cycle repeating as long as there is steam available.

From the above it can be seen that the piston is nearly at the end of its stroke when the valve reaches cut off. This arrangement does not

(*Continued on page* 452)

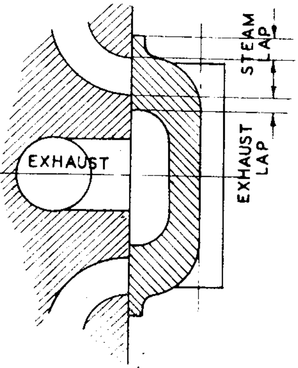


Fig. 6. Valve in mid position, showing lap

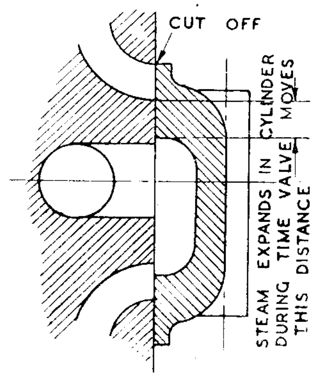
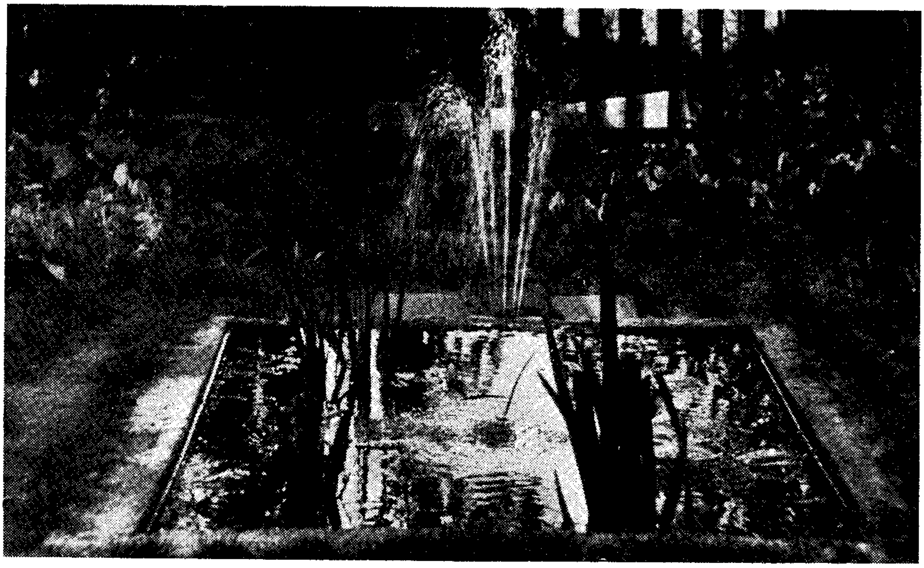


Fig. 7. Cut-off with lap

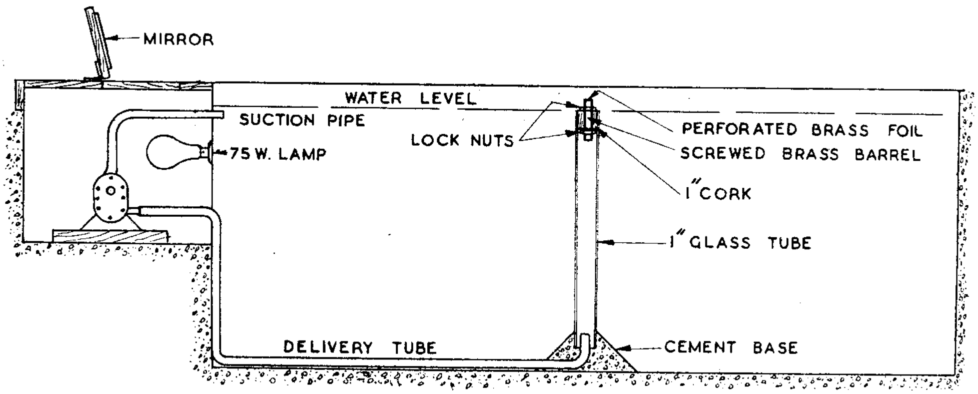
A LILY POND AND FOUNTAIN

By A. W. LAIRD

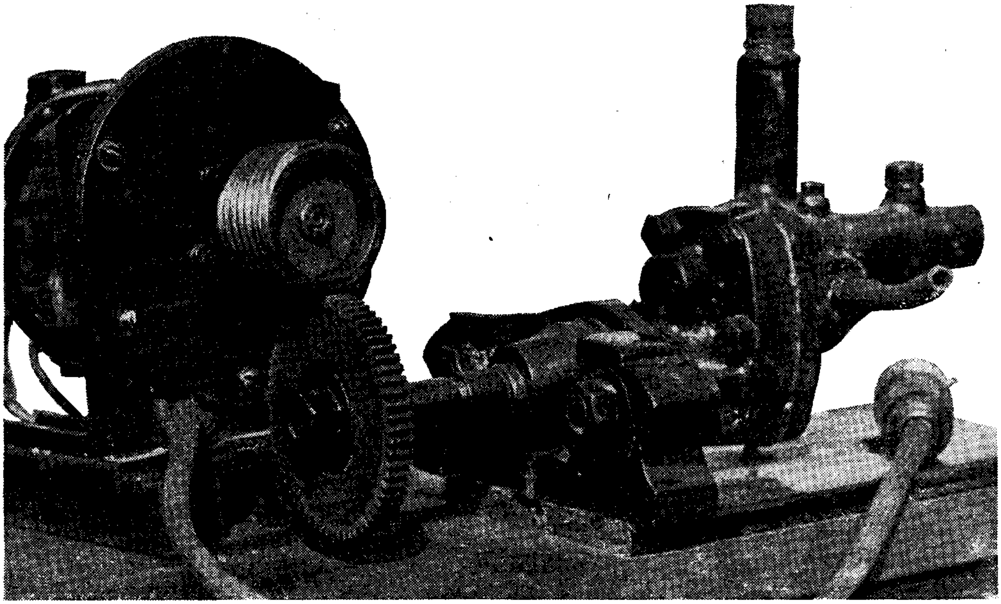


A LILY pond complete with an artificial fountain might seem too ambitious a project for most people to tackle for themselves, but with a minimum of work, and a little ingenuity, it can easily be constructed. Here are the brief details.

My Anderson shelter was sunk near the end of my garden, right in the centre of a lawn, and was later neatly concreted inside only. After the war, the steel parts were removed, leaving a ready-made pond about 3 ft. deep. The pump unit is housed in a small cast concrete compartment at one end, sunk to ground level, and wood-covered. The suction and delivery pipes pass through the side of the pond into this chamber, and connect with the unit. The delivery pipe lies on the bed of the pond, and extends to the centre, bends 90 degrees for a few inches; over it, and cemented in, is a 1-in. glass tube, which extends to the surface of the water. A brass screwed barrel passes through a 1-in. cork, and is secured with a nut at each end; it is fitted to the top of the tube, and a small round piece of brass foil soldered to the top of the barrel and carefully punched (with an old gramophone needle) to provide the jets. The best size and arrangement are found by trial and error.



Section showing the piping for the fountain



General arrangement of the electrically-driven pump

Now for the electric pump. The photograph shows the general arrangement, and consists of an old vacuum cleaner motor driving a motor-car type oil pump (gear type). The motor speed is too high for use on full current and is reduced by running in series with an ordinary light bulb (75 W).

The worm drive consists of two Ford parts—a speedometer-drive gear on the motor, and a magneto half-time gear on the pump. This gives a silent 10-1 reduction, and sufficient pressure to play five jets arranged in "Prince of Wales feathers" fashion, about 3 ft. high. With the sun on the fountain, a beautiful rainbow effect is obtained, and the running cost is about 14 hours for 1d., and at night the jets can be illuminated by reflection from the 75 W. lamp by means of a small mirror suitably adjusted, fitted to a small hinged rectangle cut out from the pump boxwood cover.

The Simple Slide-Valve

(*Continued from page* 450)

allow any time, during which steam is trapped in the cylinder, for it to do work on the piston by expansion. This fact produces an inefficient engine, for the lack of expansion does not allow the heat energy of the steam to be converted into useful work. This is why an addition to the valve is made called *lap*, which can be on either the outside or inside of the D. It depends upon this positioning whether it is called steam or exhaust lap. Lap added to the steam controlling edge is called steam lap and vice-versa. (Fig. 6.)

The angle whereby the eccentric leads the crank must be increased if lap be added to the valve so that the original lead be retained. We therefore have :—

Angle of advance of eccentric = 90 deg. + lead angle + increase due to lap.

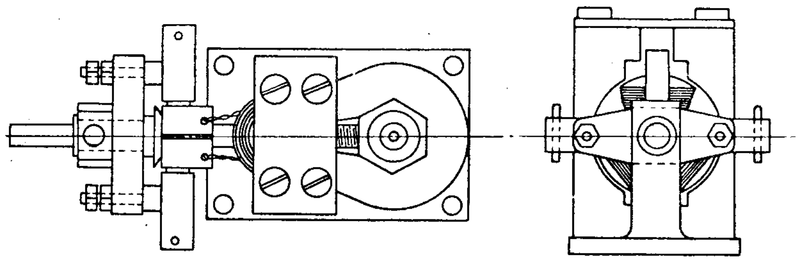
We can now consider the events of a valve fitted with lap. Starting from lead the valve moves to full opening, reverses its direction, and then reaches cut off (Fig. 7). It is from here that lap makes a difference, for the valve must travel a distance equal to the steam and/or exhaust lap (one or other may, perhaps, not be used) before opening to exhaust occurs. During this period the steam is trapped inside the cylinder, none can get in or out. It is during this time that expansion of steam from its original pressure takes place, during this expansion heat energy is given up to perform useful work in moving the piston down the cylinder. Exhaust lap has the effect of delaying opening to exhaust.

The travel of the valve is self-explanatory, and is usually the same distance as moved by the eccentric strap, which equals twice the distance between the centre of the eccentric strap and the centre of the crankshaft. In the instance of a valve with no lap and steam passages to top and bottom of the cylinder the same size, the valve travel is twice the vertical size of the steam passage. The travel must be increased if the valve is to have steam lap to be equal twice the steam opening plus the steam lap. This concluding complication is the alteration necessary to give greater opening to exhaust than to steam, and is necessary because after expansion steam has a greater volume, if it cannot get away quickly and easily a back pressure will be set up which will restrict the return of the piston to the beginning of the cycle

Construction of
A Small Electric Motor

By R. S. Shute

WHILST seeking inspiration for the manufacture of a small electric motor for use as a power-plant in a 25-in. long motor yacht, the writer noticed the re-appearance in a local shop window of some small "Eclipse" magnets (these having been unobtainable during the war). The idea of using these small, but powerful, little magnets was born, a very satisfactory and economical permanent magnet motor being the result.



These "Eclipse" magnets are 1 in. diameter by 1 in. long and $\frac{5}{16}$ in. in section, with a $\frac{1}{4}$-in. air-gap and supplied with a nickel-plated keeper, the price being 1s. 6d. each.

Construction was begun with the baseplate, Fig. 1, which must be of non-ferrous metal, either brass, copper, or aluminium, the latter if weight saving is important, and not less than $\frac{1}{8}$ in. thick, to avoid distortion. The front and back bearing pillar holes should be set out on the centre line, and the holes drilled and countersunk for the pole-piece screws.

The bearing pillars, Fig.s 2 and 3, are next taken in hand the rear post of brass being turned and screwed $\frac{3}{8}$ in. by 26, as per dimensions, and the bottom end turned and screwed to $\frac{1}{4}$ in. by 40, with the shoulder dead square.

The front bearing pillar, which can be aluminium (as this is bushed), is now drilled, tapped and fitted; in both cases the bearing holes are left undrilled—as also are the $\frac{1}{16}$-in. holes at the bases of the lubricators.

The pole-pieces, Fig. 4, are now made, and can be cast iron, iron, or mild steel. The two blocks are cleaned up all over, the rear faces especially being given a super-finish, as this is the magnetic joint.

As the magnets are now to be fitted, it should

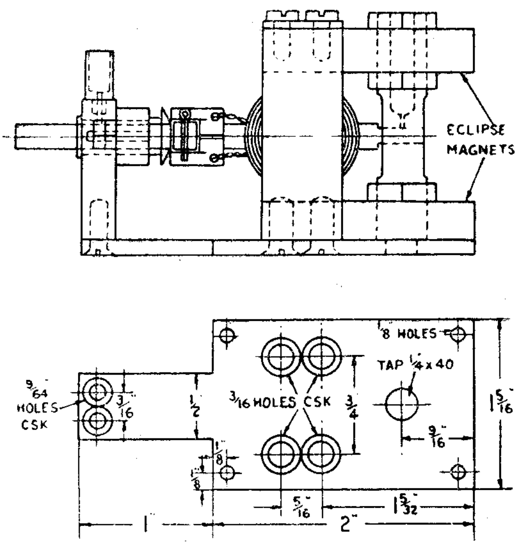


Fig. 1.

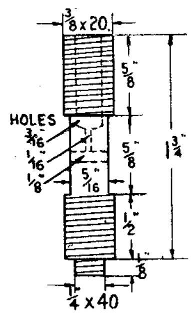


Fig. 2.

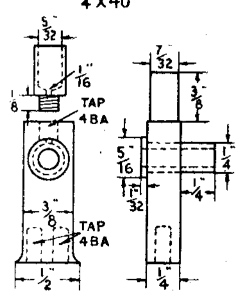


Fig. 3

be mentioned that the keepers should be left on the pole-faces as much as possible to avoid magnetic leakage. The rear bearing pillar is now screwed home as tightly as possible in the base-plate, and the two magnets fixed in position by their respective lock-nuts.

The two pole-pieces are now set up with the best faces to the magnet poles; if a piece of $\frac{1}{4}$-in. sq. steel is placed between the magnet poles and the pole-pieces clamped to it, this will help to locate

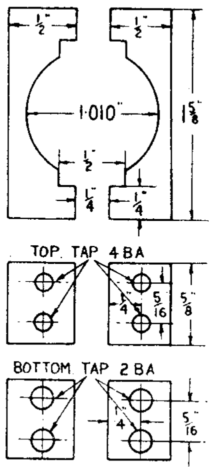


Fig. 4

them. The pole-pieces are clamped to the magnets and, when all are set square, the holes in the base are drilled through and tapped 2-B.A. Before unclamping, the top plate of brass is fitted, and the pole-pieces drilled and tapped 4-B.A. The clamps, together with the magnets, are now removed, leaving the pole-pieces and bearing pillars mounted on the base-plate. This assembly is now mounted on an angle-plate on the lathe face-plate and set up so that the centre line is $\frac{13}{16}$ in. above the top surface of the base-plate and

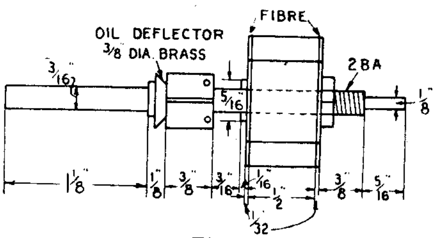


Fig. 5

on the centre line of the gap between the pole-pieces.

The front bearing pillar is now drilled; a piece of hard wood is first fitted between the back of the pillar and the pole-pieces, to support the pillar against the pressure of the drill, the hole being drilled $\frac{1}{4}$ in. diameter. The front pillar is now removed and the armature tunnel is bored to a diameter of 1.010 in., which allows 0.005 in. side clearance for the armature.

The rear bearing pillar is drilled and reamed to $\frac{1}{8}$ in. diameter and faced true around the hole. Using this method, the bearing holes and armature tunnel must be concentric. Before removing from the face-plate, scribe two vertical lines $\frac{1}{4}$ in. each side of the centre on the faces of the pole-pieces. The pole-pieces are now removed from the base-plate, and the top and bottom edges of the tunnel filed back to the scribed lines, as on drawing, and then re-assembled on the base-plate.

The hole in the top of the rear bearing pillar is now continued with a $\frac{1}{16}$-in. drill to break through into the bearing hole: this pillar is thus not disturbed in any way.

A bush, $\frac{1}{4}$ in. diameter by $\frac{1}{2}$ in. long with $\frac{3}{16}$-in. reamed hole, is pressed into front bearing pillar, and the $\frac{1}{16}$-in. lubrication hole drilled through.

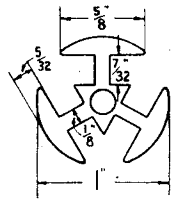


Fig. 6

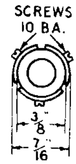


Fig. 7

The armature, Fig. 5, is of mild-steel, the shaft first being turned on centres to dimensions as per drawing.

As laminations are difficult to obtain, the writer used the sides of a corned-beef can, material which is thicker than ordinary cocoa-tins, with excellent results. Using this material, which is 0.012 in. thick, 36 laminations will be required, making approximately $\frac{1}{2}$ in. length of armature.

The method adopted was to make a template of $\frac{1}{16}$-in. sheet steel with a $\frac{3}{16}$-in. centre hole, Fig. 6; the "tin" is marked off in squares and $\frac{3}{16}$-in. holes drilled in the sheet. A $\frac{3}{16}$-in. peg is held in the vice; each hole in the sheet placed over it in turn with the template on top, a small chisel being used to cut around the legs of the template and a scribed line made around dia-

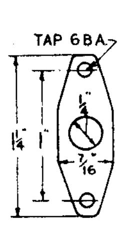


Fig. 8

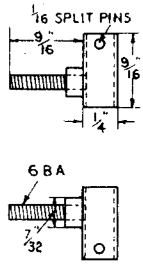
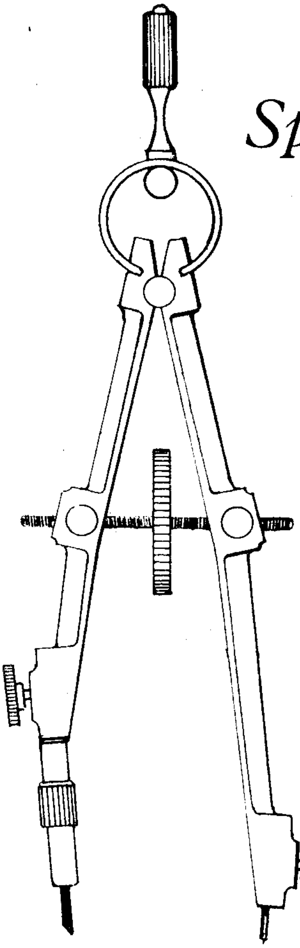


Fig. 9.

meter, each individual lamination is then trimmed up with tin-snips; about $1\frac{1}{2}$ hours should be enough time to complete the lot. They are then shellaced on one side and placed on a $\frac{3}{16}$-in. rod and held in the chuck, and when all are assembled, the tailstock brought up to press the lot together, after two days or so, it will be found that all are

(*Continued on page* 457)

A Pair of 4-in. Spring-Bow Compasses



By G. E. DICKEN

THE compasses, construction of which is described in the following notes, will be found extremely useful to the model engineer who does his own designing, as well as to the professional draughtsman. Their capacity, 0 in.-4⅛ in. diameter, is such that they combine the functions of spring-bows and bows in both pen and pencil, and the centre-screw adjustment is a great convenience.

To start, obtain (an all-embracing term) two pieces of ¼-in. square mild-steel bar, bright drawn preferably, about 5 in. long. Clamp together and drill a neat-fitting hole for a screw at each end, through both bars. Screw firmly together, square the ends of the double bar, and drill a centre on the dividing line at each end.

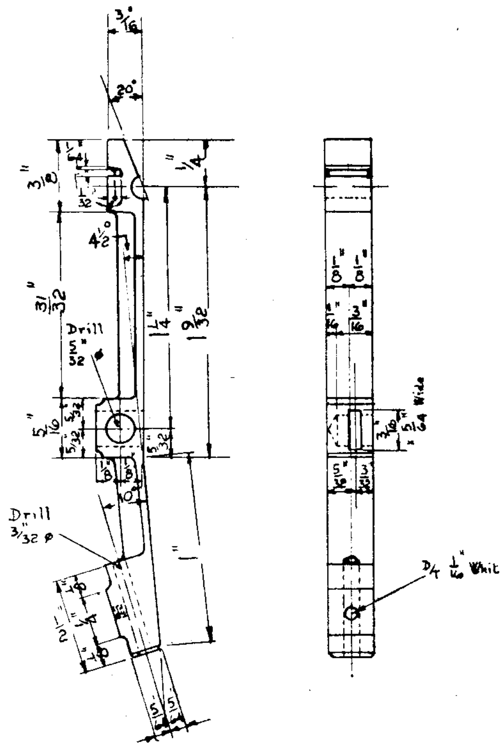
Mark out both compass legs, centre-punch, drill, and preferably reamer the ⅛-in. pivot hole. Note in the marking out, the angle of bend in the legs is ignored for the present. Drill the 5/32 in. diameter holes for the nuts, and then at 90 deg. drill three $\frac{1}{16}$ in. diameter holes close together to start the slots. A fretsaw or jeweller's saw, and a small file will soon clean these up to size on the outside of the bars. The insides can be left until the bars are dissembled.

Mount the double bar between centres and turn from the pivot-block down to the top of the nut housings to leave about 1/32 in. of flat on the edge of each bar. Then turn from the bottom of the nut housing to the top of the chuck holder, to the same diameter as previously. Cut away the pencil leg, taking care to leave the screws and centres intact. The bar can now be replaced between centres, and the last portion of the needle leg turned down.

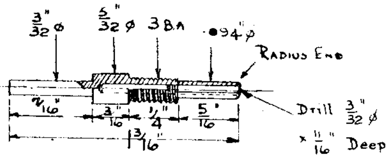
Make a template of 4½ deg. and 6 deg., grip each leg in turn in the vice, using fibre jaws, and bend them to their respective angles.

The legs can then be finished to shape by filing and the necessary holes drilled and tapped. A good finish can be obtained by rubbing flat on a hone.

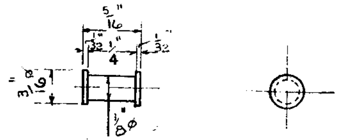
The turned parts are a straightforward job. As no knurling tools were available, the old dodge of racking a sideways-held screwcutting tool across the work was used.



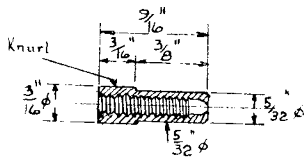
Pen-pencil leg



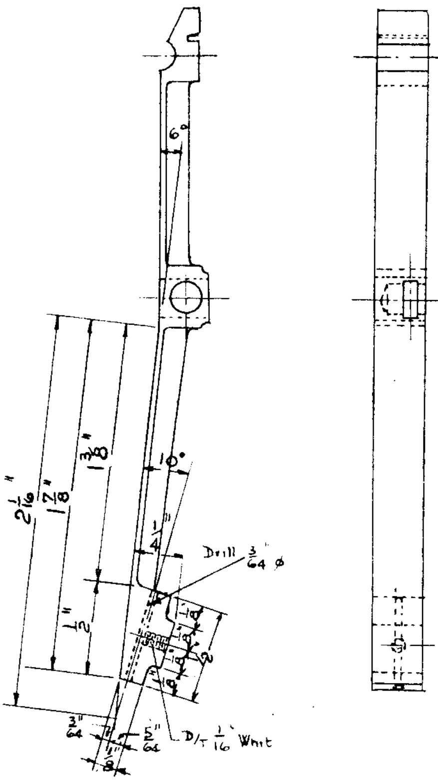
Chuck spindle, 1 *off silver-steel. Cut four slots* $\frac{5}{16}$ *in. deep with jeweller's saw or fretsaw down* 0.094 *in.* ø *end*



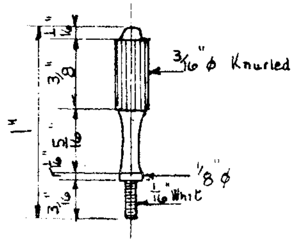
Pivot-pin, 1 *off silver-steel. Make tight fit in legs*



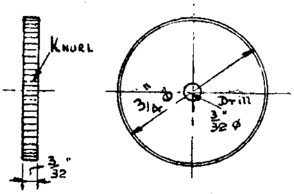
Chuck body, 1 *off silver-steel. To make :—Chuck* $\frac{3}{16}$*-in. rod, drill through* 3/32 *in.* ø, $\frac{5}{8}$ *in. deep from faced end. Re-drill* $\frac{1}{8}$ *in.* ø 17/32 *in. deep, leaving drill-point angle at bottom of hole, turn down body at chuck end; tap* 3 *B.A.,* $\frac{3}{8}$ *in. deep*



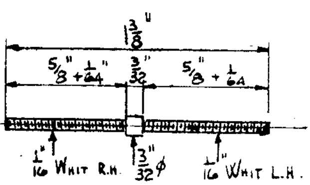
Needle leg



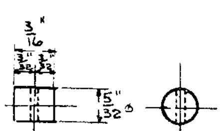
Mild-steel pin, 1 *off*



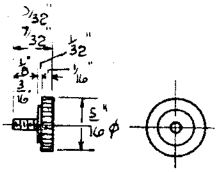
Adjusting wheel, 1 *off mild-steel*



Centre screw, 1 *off silver-steel;* 3/32 *in.* ø *swell to be press fit in adjusting wheel*

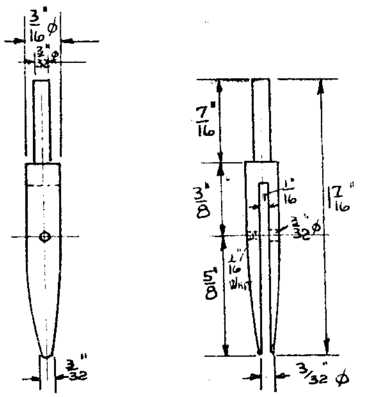


Mild-steel nut,
2 *off tapped* $\frac{1}{16}$*-in. Whit. R.H.*
1 *off tapped* $\frac{1}{16}$*-in. Whit. L.H.*

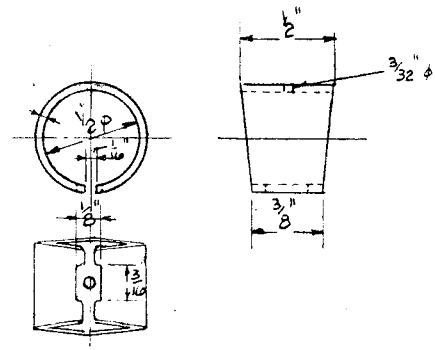


Mild-steel screw,
1 *off with* $\frac{1}{8}$*-in. of thread*
2 *off with* $\frac{3}{16}$ *in. of thread*

ø*=Diameter.* *D/T=Driller and Tapper.* *G=Gauge*



Pen extension 1 *off silver-steel. Finish dead smooth, harden and temper, polish and grind points when closed together*



Spring, 1 *off*

The screws were all made by dies, although it would be advantageous to have a quick thread on the centre screw if a screwcutting lathe is available.

The spring and pin were purchased from the local tool shop, being stock spare parts for dividers. The sizes are given for ordering or making.

The pen is turned down to 3/32 in. diameter at the point with a flat end. The slot is cut with a $\frac{1}{16}$ in. wide midget type hacksaw blade. The points are screwed together tightly and ground to a chisel-rounded end, so that both sides match.

In the prototype the pen was polished with the help of a friend in the trade.

The whole of the compasses were burnished with the end of a drill, a very smooth and pleasing appearance resulting.

A Small Electric Motor

(*Continued from page* 454)

stuck together in one solid mass which can be mounted on the armature-shaft together with a fibre duplicate at each end. As a safety precaution, it is as well to bind each leg with wire before turning the outside diameter, which will require a very sharp tool and small cuts to finish to a diameter of 1 in. The wire is now removed and the bare metal portions inside the legs insulated with empire tape stuck in place with shellac or Durafix.

The commutator, Fig. 7, is a piece of ebonite turned down to take a piece of $\frac{3}{8}$-in. bore brass tube—a tight fit. This is now turned true and the hole drilled $\frac{3}{16}$ in. for a tight fit on the shaft. Three slots are marked out, and $\frac{1}{8}$ in. from each slot position in the centre of the tube six hole positions marked out, and one more in the centre of each section at 3/64 in. from the outside edge for the connection screws. All these nine holes are drilled and tapped right through for 10-B.A.

Pieces of 10-B.A. rod are now screwed into the six holes of the centre-line, about 1/32 in. short of the shaft hole, and cut off flush with the surface. The three remaining holes are fitted with 10-B.A. cheese-headed screws, also *not* long enough to bottom on the shaft. The three slots can now be cut through to the ebonite.

The commutator is mounted on the armature-shaft with the slots in line with the centre of the lamination legs and turned true.

The wire used for windings is 36-gauge, double silk; or enamelled wire could be used, 27 yards being required, i.e. 9 yards per leg, which gives 170 turns per leg. Direction of winding is immaterial provided that all three coils are wound in the same direction. The connections are the start of one coil to the end of the next, the two ends being bared, twisted together and each pair fastened to the commutator by the 10-B.A. screws.

Although these connections are invariably soldered to the commutator, the heating up of the insulating material on small commutators whilst soldering usually softens the material which eventually causes loose segments. The windings can now be shellaced or baked or painted over with Durafix, which is perhaps the easiest method.

The brush yoke, Fig. 8, is of paxolin or ebonite, $\frac{1}{4}$ in. thick, and is a push-fit over the bearing extension. The brush-boxes, Fig. 9, are square made from $\frac{1}{4}$-in. brass tube, or made up from sheet. A 6-B.A. hole is tapped in each, and a piece of 6-B.A. screwed rod screwed in, together with a collar on each; all is now sweated together. The brush-springs were made from Schrader valve springs opened out, and a little experiment is needed to give a very light tension to the brushes.

The brushes are of carbon cut down from motor-brushes, and should be an easy fit in the holders and $\frac{5}{16}$ in. long, the brushes and springs being retained in position by $\frac{1}{16}$-in. split-pins.

For use in a boat, the writer used a $2\frac{1}{2}$-to-1 step-down gear drive to the propeller shaft, the final speed being approximately 800 r.p.m. The motor runs well on either 4 or 6 volts, taking 0.3 amps. at 4 volts.

For lubrication purposes, push a piece of wool down the $\frac{1}{16}$-in. holes in the lubricators, fill up with cotton-wool and use a light oil like sewing machine oil, etc.

"A TEST"

By "Pro"

If it hadn't been for George, things would perhaps not have been so bad, but when a chap insists on helping—well, there you are. He's not such a bad chap, but very practically-minded, and he insisted on being there at the kill.

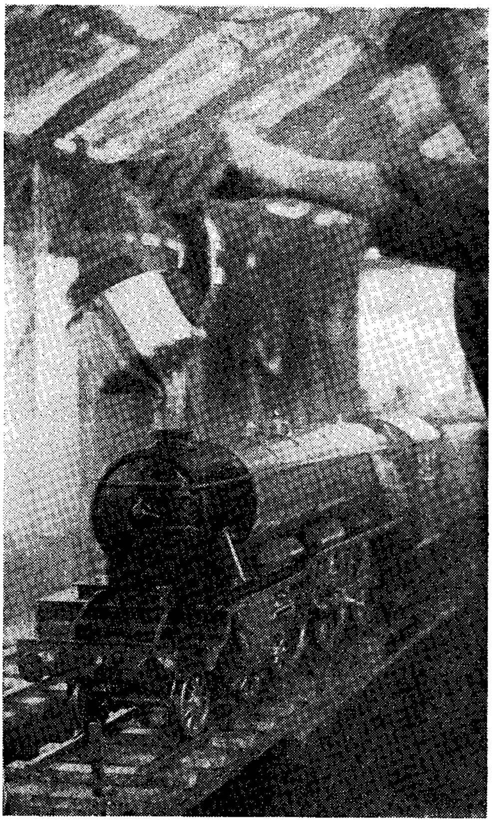
His actual job was to wrestle with the tender pump, and to anyone who had not seen George at work this might not seem too Herculean a task on a 3½-in. gauger. But, to see George in operation—under full steam, one might be excused in saying—was more or less to witness an epic.

But to explain more fully what led up to the above event. It was the culmination of many months of patient waiting interspersed with hours of sweating toil—two years in all. A "Flying Scotsman" which we hoped would live up to its name, even if it was a first attempt.

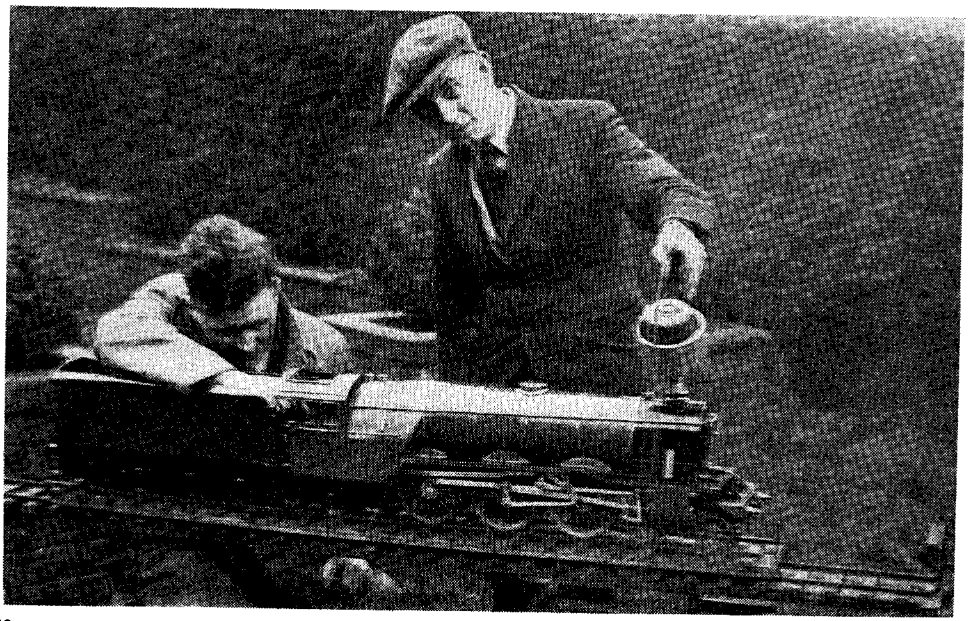
How often had we thought of the time when steam would first be raised and now here we were, at seven o'clock in the evening, surrounded by all our impedimenta necessary to the tyro's initial endeavour and with willing hands eager and ready to help in the consecration.

The ceremony took place in—of all places—the greenhouse, which had long since had its array of choice blooms bequeathed to all and sundry to make way for progress in the form of model engineering—a sorrowful act, but necessary, due to the force of circumstances.

The floor of good earth laden with well-rotted



"Albert" raising steam with a vacuum-cleaner



"Albert" and "Geof." at it again!

manure had given place to one of solid concrete. The glass, once so transparent, was now painted white, albeit a nice change from the black daubed on in the not-so-long-ago.

On the rude bench—timber still being so scarce—reposed the innocent victim in all its painted glory, worthily straddling the steel track.

And so, to this quiet garden retreat, in an ordinary respectable suburb, we eagerly wended our way, armed with kettle, blowlamp, coal scuttle, matches, 'baccy and anything else our ingenious minds thought necessary for such an occasion.

We had a plan, of course! This was to raise steam by using a blower composed of a pipe wedged in the chimney, in which we hoped to induce suction by means of a jet of steam obtained from an outside source, which in this case was a tin boiler with a blowlamp underneath.

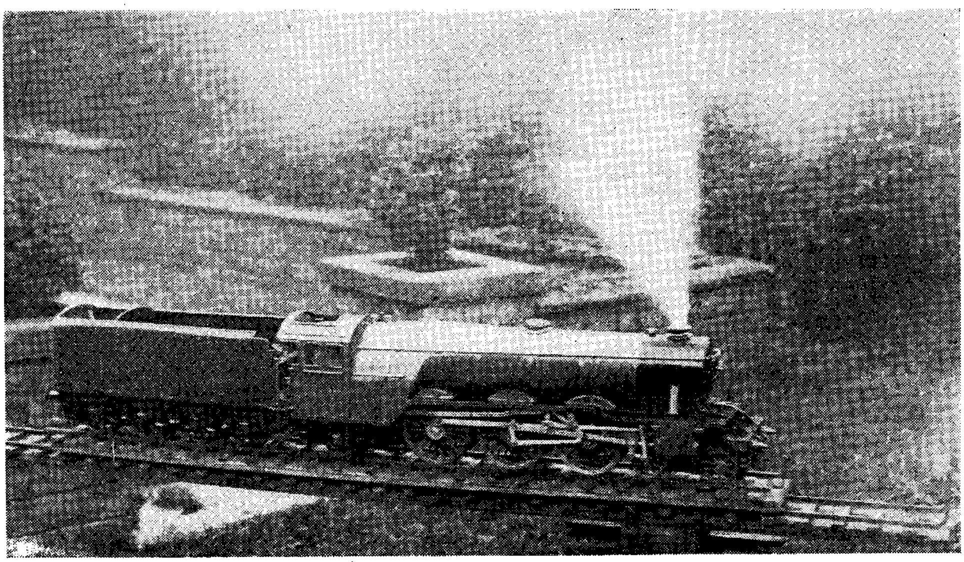
stopheles gloatingly feeding small coals to the now vigorously burning fire.

With such rigorous procedure, our chief want was for fresh air and, with streaming eyes and blackened faces, we filled our lungs, only to return even more quickly than we left, to keep the pot boiling, so to speak.

As a matter of interest, we should say that vacuum cleaners stand up to flames pouring through them for a good half-minute, after which—well, they are too darned hot to hold.

But we had achieved something. This was very obvious. In place of smoke and flames we now had wet steam. How we revelled in this. Soon should come the consummation of our efforts.

A beautiful sizzling sound could be heard as leaky fittings made their presence known. But lo! the gauge read 40 lb.! The moment had arrived! With due deliberation, Albert, the chief



A " live-steamer "

Well, the theory may be all right about this, but our adaptation of it must have been far from perfect, as all we got for our pains were burnt fingers and a rise in room temperature. But we are used to small drawbacks such as these and, as one might put it, this only lent fuel to the fire. The next bright thought was the vacuum cleaner. What a grand source of power. No sooner thought of than done; this boon to every household, made its welcome appearance. So, off with the bag! Hoist over the chimney! Stoke up the fire! Turn on the juice!

Will we forget the result, or shall I say—would you—if you had seen how showers of sparks can pass in and out of such a machine?

As if in a trice, another act in the drama took place; we found ourselves in the blackest of smoke.

How such a small machine could blow out such a volume in so short a time is hard to believe, and as if inducement were necessary to egg on the whirring demon, friend Geof. sat like Mephi-

conspirator, turned the regulator and, with studied care, gently pushed the object of our affections—just in case. Crowding round, so as not to miss anything of the beauty of this moment, we were all fittingly welcomed with a shower of hot water and oil from the cylinders. What a reception! But wait! Have we tamed the vibrant beast or haven't we?

Yes! slowly the wheels turn and then we know fate is not always against us. Our eight-foot of track is woefully short and calls for reverse gear almost before we can start. But though we know the timing must now be adjusted, fittings made steam-tight and a stay or two likewise, we feel we have achieved something.

However, this was the danger period, as we felt we had not done enough to urge on the machine. The engine's steam blower worked even better than we had hoped and, turning this on, we soon filled the whole place with steam.

Albert's wife, dutifully carrying water to us, felt certain there was more steam in the greenhouse

than the boiler, judging by the way it emanated from the door and ventilators, as with blackened face she too stood and watched our efforts, especially those of George, who, as I said at first, bent to his task, in more ways than one, and gallantly manned the tender pump, and, with an eye sort of glued to the water gauge, managed somehow to keep up with our reckless inefficiency, at the same time bantering us about the amount of electricity needed to start a steam engine.

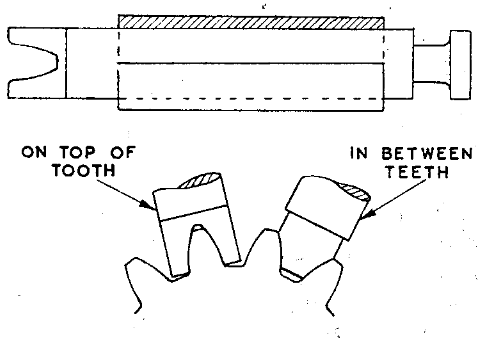
I believe we burned more coal in our two-hour trial than it takes to run a 5-in. gauger a whole afternoon while pulling a load of kiddies.

But why worry? We feel sure we have succeeded, and are no worse off, except for a few burnt fingers and a mess on the floor, and after a good overhaul we should soon be doing real track work.

Letters

Indexing in the Lathe

DEAR SIR,—With reference to "Ned's" article on this subject in the January 30th issue, Some time ago I made an index for the cross-slide screw on my lathe. I wanted a hundred divisions, and all I had to do it with was a 50-toothed change wheel, which would only give 50 divisions, so I schemed out a simple plunger,



similar to Fig. 50 in THE MODEL ENGINEER, January 30th. The difference being that on the broad face of the plunger, the shape of the wheel teeth was also cut, by which I could divide accurately the distance between two teeth—result, 100 divisions on a 50-wheel. I know quite well that a dividing head is the thing for the job, but not every model engineer owns one, or has time to make one. Any change wheel can be used on the lathe, and the teeth can be doubled by the above method. Needless to say, the plunger fit in the body, and the bifurcated end must be made accurately; I filed mine to fit the teeth, and made sure that there was no movement of the mandrel if the plunger was turned 180 deg. for either division.

Yours faithfully,
Hexham-on-Tyne. S. L. HORNSBY.

M.R. Single-Wheelers

DEAR SIR,—May I express my personal thanks to Mr. Hambleton for his most beautiful drawings and informative notes on the Midland Singles in the issue dated March 13th.

Locomotive beauty is undoubtedly, to a degree, in the eye of the beholder, but a few will disagree that amongst single-wheelers, the long series of S. W. Johnson's lovely engines take a very high place. To me, they rank easily first, for they combine beauty of proportion, line, and almost perfect symmetry. Stroudley's "Grosvenor" and "Stephenson" were, again in my personal opinion, ruined in appearance by placing the dome so far back, and by the externally ugly cab (which in all fairness was probably a lot more comfortable than Johnson's more graceful, but distinctly exiguous cabs). Dean's beautiful singles, the 4-2-2 "Achilles" series were, to me, just short of perfection in the placing and size of their domes.

On the other hand, I always had a sneaking feeling that Johnson's engines would be improved in appearance if the bogies had had outside frames, as did the G.W. engines. I had the privilege, as a very young man, of meeting Mr. Johnson after his retirement, and I well remember, on my expressing my admiration for his *Princess of Wales*, his telling me that he always considered that the last of his 7 ft. 6 in. singles were better all-round engines, as in the later ones he had provided too much tractive power for the weight available for adhesion; coming from such a distinguished locomotive engineer, that is a statement upon which it is well worth while to ponder. Mr. Johnson was not only a brilliant locomotive designer, but a very fine English gentleman of a type fast becoming extinct; no finer compliment can be paid to his memory. There is an obvious misprint at the start of the article "1899," should be 1889.

So far as my memory takes me, there was no Paris Exhibition of 1899, but there was one in 1900, and at this Johnson's *Pricess of Wales*, No. 2601, was shown and, again from memory, received the Grand Prix.

One other small point. Mr. Hambleton refers to the *first* 4-2-2 engines with inside cylinders as being the G.W. rebuilds of Pearson's Bristol & Exeter 4-2-4 tanks, and gives the date at 1877. The type appeared 30 years previously in 1847, on the G.W., the "Iron Duke" of that date being one of the pioneers, with 8 ft. 0 in. wheels, and 18 in. × 24 in. cylinders. Twenty-two were built between 1847 and 1851. It is true that these engines were not bogie engines, the four leading carrying wheels being mounted in the main frames, but they were 4-2-2-'s just the same. Another engine, this time a genuine bogie 4-2-2, with inside cylinders pre-dated the Bristol & Exeter conversions by 19 years, that was Sturrock's 4-2-2 of 1853, for the G.N. Railway; this had 7 ft. 6 in. driving-wheels and 17 in. × 24 in. cylinders.

I am sure Mr. Hambleton will accept the fact that these notes are not put forward in any spirit of carping criticism, but with a desire to amplify the information he gives. It can truly be said of Mr. Hambleton's drawings that they are things of beauty and a permanent joy; once again, my thanks.

Yours faithfully,
Harrow. K. N. HARRIS.

QUERIES AND REPLIES

Enquiries from readers, either on technical matters directly connected with model engineering, or referring to supplies or trade services, are dealt with in this department. Each letter must be accompanied by a stamped, addressed envelope, and addressed "Queries and Service," THE MODEL ENGINEER, 23, Great Queen Street, London, W.C.2.

Queries of a practical character, within the scope of this journal, and capable of being dealt with in a brief reply, will be answered free of charge.

More involved technical queries, requiring special investigation or research, will be dealt with according to their general interest to readers, possibly by a short explanatory article in an early issue. In some cases, the letters may be published, inviting the assistance of other readers.

Where the technical information required involves the services of a specialist, or outside consultant, a fee may be charged depending upon the time and trouble involved. The amount estimated will be quoted before dealing with the query.

Only one general subject can be dealt with in a single query; but subdivision of its details into not more than five separate questions is permissible. In no case can purely hypothetical queries, such as examination questions, be considered as within the scope of this service.

No. 8013.—Choice of Small Lathe.
F. B. S. (New Ferry)

Q.—Having recently been demobilised from the R.A.F., I wish to take up model engineering as a hobby, but have a very limited amount of money to spend on equipment, and should welcome your advice on the selection of a small and inexpensive lathe. Can you recommend the $1\frac{5}{8}$-in. lathes now being advertised in THE MODEL ENGINEER or would it be preferable to obtain a larger lathe second-hand? My main interest is in building model cars and power-driven aircraft, including model petrol engines of about 2.5 c.c.

R.—It is very difficult to advise you on this matter, as it is not at all easy to obtain any kind of lathe at present. The requirements of a lathe for making very small petrol engines are fairly exacting, but even the simplest types of lathes can be made to produce good work if carefully handled. It is possible to make such engines on the $1\frac{5}{8}$-in. lathe suggested, but it is rather on the small side and, from personal experience, we should recommend a larger lathe, such as the Myford $3\frac{1}{2}$-in., which is used by many model engineers, whose work has been described in THE MODEL ENGINEER. This lathe is as near as possible to your target price, but its equipment will call for some further expense, though this might be built up gradually.

No. 8016.—Batteries for Model Boat Propulsion.
G. V. C. (Barnehurst)

Q.—I have a 39-in. cabin cruiser, fitted with a motor rated at 6-8 volts, and wish to install the most efficient type of battery for driving it. Will you inform me whether three of the Nife DW 13 lightweight accumulators, as described some time ago in THE MODEL ENGINEER, connected in series to produce $7\frac{1}{2}$ volts, would supply the required amount of current for long periods, say, half an hour at a time?

R.—We cannot advise you whether the batteries mentioned are suitable for your purpose, unless we know the exact full power consumption of the motor your propose to use. It is, of course, quite practicable to connect the batteries in series to obtain the necessary voltage, but the wattage required to produce power for boat propulsion generally involves a high current consumption, and batteries of small ampere-hours capacity are not capable of keeping such a motor running for a very long period.

For the most reliable information on this matter you should apply to Nife Batteries Ltd., Grosvenor Gardens, Victoria, S.W.1, stating current output required. They will be able to inform you whether the batteries specified are suitable for your purpose, and if not, to recommend another and more suitable battery of the nickel-cadmium type.

No. 8012.—Trouble with Model Petrol Engine.
J. W. P. (Wilmslow)

Q.—I have built one of the "Atom Minor" Mark II engines, from a MODEL ENGINEER drawing, and have encountered a very mysterious trouble, so I wonder if you could oblige with any advice.

The engine starts up perfectly after about three flicks of the propeller. I can then run the engine up in the normal manner to full speed, and to all intents and purposes, everything is all right. However, after running for a time, the engine's revs. suddenly start to drop, petering away very quickly, and finally stopping. Adjustment of the needle-valve or contact-breaker have no effect, except that in the case of the needle-valve, if I open it up several whole turns, I can with difficulty keep the engine going, but I have to be quick about it.

R.—It is always very difficult to diagnose engine trouble without actual inspection, but the symptoms you describe are not at all uncommon, and the usual cause is purely mechanical, though often supposed to be due to fuel feed restriction. In small engines, especially when new, slight distortion or unequal expansion of the piston or cylinder often takes place, causing a partial binding of the working parts when the engine warms up. Sometimes an increase in the fuel supply will help to keep the engine going against the increased friction. The trouble often rectifies itself when the engine is properly run in, but, if not, careful inspection of the parts will indicate high spots, which must be eased off to allow free working.

No. 8014.—Model Two-stroke Engine Design. C. E. C. (Belfast)

Q.—I have a small engine of American manufacture which has given very unsatisfactory results, and I propose to reconstruct it in an improved form. Your advice on the following points of design would be appreciated :—

(1) What should the length of the piston be, in relation to the stroke ?

(2) The above engine has a short piston, so that the inlet port is uncovered not only at top dead centre, but also at the bottom of the stroke as well. What is the reason for this ? Is its effect similar to that of "overlap" in the valve timing of four-stroke engines ?

(3) Should the ports in the piston and the lower transfer ports in the cylinder line up exactly at bottom dead centre ?

(4) What is the correct proportion of the piston and connecting-rod weight, which should be balanced by the counterweight on the crankshaft ?

R.—We trust that the following answers to your questions will prove helpful :—

(1) The piston should always be slightly longer than the stroke, the exact amount of overlap being usually limited by the necessity to avoid excessive height of the engine ; but within limits, the longer it is the better.

(2) In our opinion, most engines in which the intake port is opened by the top edge of the piston at bottom dead centre are just simply badly designed, this point being unforeseen by the designer. It may upset running very considerably, by its adverse effect on carburation, though it is often claimed to assist scavenging at high speed.

(3) Exact register of the piston ports with the lower transfer ports in the cylinder is not highly important, and these do not have to be precisely timed ; providing, however, that the opening area is at least as great as that of the upper transfer ports when the latter are fully open.

(4) It is usual to balance out approximately *half* the reciprocating weight, plus *all* the rotating weight, by means of the balance-weight on the crankshaft, but the exact amount depends on various features of engine design and arrangement, and in any case, perfect balancing of a single-cylinder engine by any normal means is impossible.

No. 8017.—Lathe Mandrel Design. H. E. B. (Burton-on-Trent)

Q.—I am building a lathe headstock and am in some doubt as to what type of bearing to fit. If possible, I want to operate the headstock through speeds of 20 r.p.m. to 1,500 r.p.m. and to do both metal turning and wood turning. Would the fitting of Timken taper roller-bearings give a bearing stiff enough for metal turning ?

If you don't think the roller-bearings would be a success, would the fitting of an opposed cone mandrel, running in gunmetal bearings, be a success, and would a ball thrust-bearing be needed ? What should be the angle of taper of the cones ?

I have read in THE MODEL ENGINEER of "hardened cone bearings." Does this mean that the bearings and mandrel journals are made of a steel capable of being hardened and tempered ?

R.—There are several practical problems in the fitting of any kind of ball- or roller-bearings to small lathe headstocks, and although the Timken type of taper roller-bearing has been successfully used in some cases, plain bearings are preferred by most users, especially when a wide range of speed is required, as in your case. Opposed cone bearings are quite successful if properly machined and fitted, but to all practical intents and purposes, a parallel mandrel, running in well-fitted bronze or cast-iron bearings, is entirely satisfactory for general work. A hardened mandrel is desirable in any case, but calls for precision grinding, and if facilities are not available, it is best to avoid the need for any heat treatment after machining. Cone bearings are generally tapered at 15 to 20 degrees included angle, and it is usual to provide an obtuse taper on the collar of the mandrel to take end thrust.

No. 8018.—Model Petrol Engine for Boat. K. O. (Catford)

Q.—I have a 30-c.c. "Grayson" water-cooled engine, in respect of which I am seeking information. The makers are unable to help me since they have discontinued this class of business. Can you answer the following enquiries ?

Firstly, regarding the cooling system : I was proposing to couple a small centrifugal pump to the engine ; what rate of flow do I require?

Secondly, regarding lubrication : I assume this is achieved by the "splash" of the crankshaft in the sump—am I correct ? But there appears to be no provision for lubrication of the timing gears and cams within the timing cover. Should the lower gear-wheel be allowed to run in oil ?

The hull will be 3 ft. 6 in., launch-type, with twin screws. What size propellers should I use, and from where might I obtain them ?

Lastly, the engine is fitted with a standard type full-throttle carburettor. I propose replacing this with one incorporating a variable throttle.

R.—We regret that we cannot inform you where to obtain any spare parts, either new or send-hand, for a Grayson petrol engine, owing to present supply difficulties. The rate of water flow required for cooling a small petrol engine cannot be computed accurately ; only a very small rate of flow is required, and even the smallest centrifugal gear-wheel pump will usually provide an adequate output. Boat engines are often cooled by means of water circulation, provided by a simple scoop which picks up water by the forward motion of the boat. Lubrication of these engines is usually effected by continuous feeding of small quantities of oil into the crankcase, such as by a drip-feed lubricator, and the gears and other internal parts are thus kept lubricated by oil mist. Twin propellers are of dubious advantage on small boats, as it is extremely difficult to get them to take an equal share of the load, and the size and pitch of propellers is always a matter for experiment. A suitable automatic carburettor for this engine would be the "Atom" Type R, fully detailed blueprints of which can be obtained from our Publishing Dept., price 2s. 9d. post free.